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QUARTERLY

OF THE

National Fire Protection Association

Subscriptions to the QUARTERLY are accepted only as a part of the general publications of the Association which are sent to members. Associate membership is open to anyone interested; annual dues $10.

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60 BATTERYMARCH STREET, BOSTON, MASS.

Application Blank for Associate Membership

Associate Membership is open to any Society, Firm, Corporation or Individual interested in the protection of life and property against loss by fire. Persons in every walk of life are members.

National Fire Protection Association

INTERNATIONAL

Organized 1896

EXECUTIVE OFFICE: 60 BATTERYMARCH STREET, BOSTON, MASSACHUSETTS

All the valuable engineering and popular literature issued by the Association is sent, as issued, to every member.

We furnish free to members the Regulations issued by the National Board of Fire Underwriters, and the lists of devices and materials inspected by Underwriters' Laboratories, Inc.

The Association is the clearing house for all the authoritative information on Fire Protection and Prevention and members are privileged to submit to it their individual problems for solution.

PUBLICATIONS

Quarterly Magazine of the Association. A chronicle of the Association's activities, with valuable contributions of articles on fire prevention and protection and special hazards, and compilations of fire statistics on various classes of property.

News Letter. A special monthly bulletin of timely information on fire prevention and kindred subjects.

Proceedings of Annual Meeting. Containing stenographic report of transactions of the Association and the discussions incident to the adoption of its standards.

Special reports, bulletins, etc., issued frequently during the year.

Year-book and directory. Complete list of members with addresses.

Index to all subjects covered in the Printed Records.

NATIONAL FIRE PROTECTION ASSOCIATION,
60 Batterymarch Street, Boston, Mass.

Please enroll me (or us) as an associate member, and forward the publications to which members elected this month are entitled. I transmit herewith $10.00 as my annual membership dues, which includes a year's subscription to the "Quarterly" of the National Fire Protection Association.

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Membership year begins with date of election.

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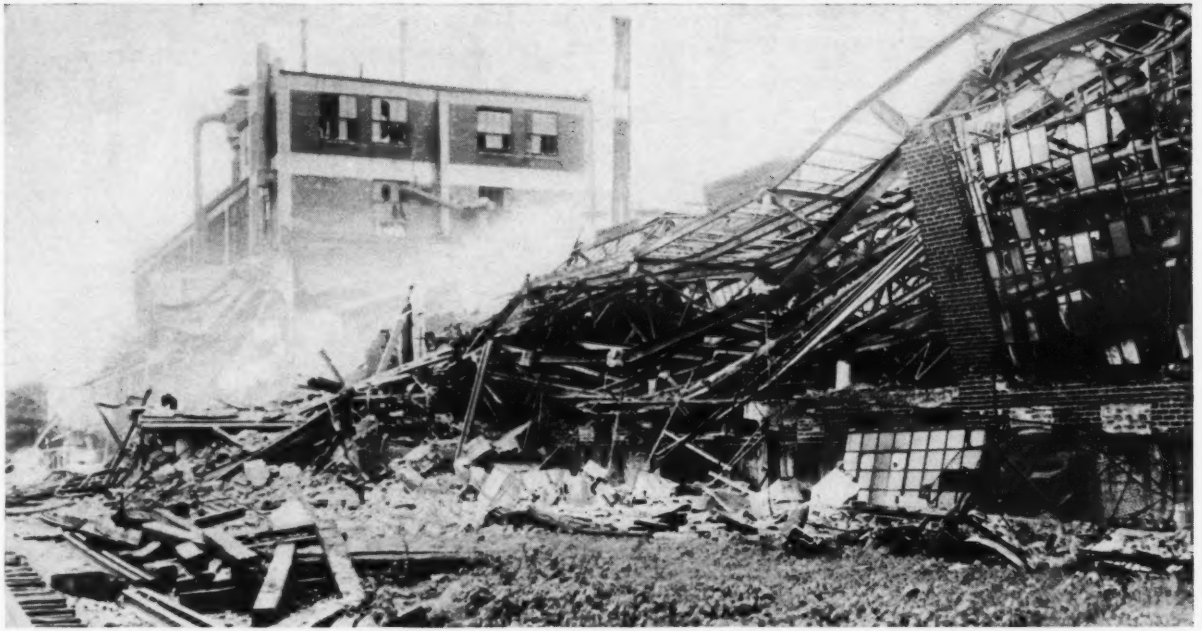

Acme.

The Doehler Die and Casting Company plant at Toledo, Ohio, after a gas explosion on July 4, 1939. Two maintenance men failed to cap the end of a three-inch gas line before turning on the gas. They inspected the risers to the three-inch line but not the end of the line. The blast caused injuries to six workmen and broke windows of buildings within a quarter-mile area. Chief Inspector E. R. Walterschied of the Toledo Fire Prevention Bureau reports, "Our city otherwise enjoyed a very successful 'Fourth of July,' as only one fire was caused by fireworks." This explosion, which caused an estimated $40,000 loss, serves to emphasize the importance of following the detailed procedure outlined by N.F.P.A. Good Practice Requirements when turning on gas supplies.

The Quarterly

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The 1939 "Year Book." Listed in the 1939 "Year Book" and Membership Directory, printed as Part II of this QUARTERLY, are 4799 members, an all-time high record for any similar annual list in the history of the Association. In 1930, the previous high record, there were 4784 members at the time of the annual meeting and 4745 listed in the Year Book. The net gain of sixteen hundred members from the depression low of 3164 in 1933 is a remarkable evidence of the vitality of the fire protection movement. Total gains were of course larger, for there are always some losses in our membership due to death, business changes and other reasons.

For some time the membership was almost static. Then a slow growth became apparent. The major gain has been in the past two years, under the energetic leadership of Membership Committee Chairman H. E. C. Rainey. Mr. Rainey has shown that there are thousands of prospective members in all walks of life who need only to be told about the work of the Association and the value of its service. His energy, persistence, and above all his whole-hearted belief in the cause of fire protection and his devotion to the N.F.P.A. have been an inspiration to all our members. Mr. Rainey appreciates that the N.F.P.A. campaign for the reduction of loss of life and property by fire rests entirely upon our own membership, and that wide extension of the membership is necessary for success.

* * * * *

Fire and War. In times of peace fire protection authorities have to deal only with accidental fires and occasional incendiary fires set for profit or by mentally deranged persons. In war, however, fire may become a major element in malicious destruction, and the entire emphasis of fire prevention effort may be changed.

Far greater damage can be done by incendiary bombs that propagate their destruction wherever there is material to burn than by explosives whose force, however terrible, is limited to the immediate area where the bomb hits. Newspaper reports indicate that incendiary bombs were largely used in Poland, but at this writing there is no information as to the extent of the damage by fire.

European cities, where non-combustible construction is more general than in North America, are presumably less susceptible to conflagrations caused by incendiary bombs than our cities, where combustible construction predominates. Cities with large areas of closely spaced wooden buildings, particularly where wooden shingle roofs are used, are peculiarly vulnerable to attack by incendiary bombs which might simultaneously start many more fires than could be handled by the fire department.

Sabotage by fire is likewise a real danger, not limited to areas within reach of hostile bombers, but likely to occur anywhere that war supplies are being produced. Fire as a method of sabotage offers possibilities of destruction far greater than by the use of explosives, which are closely controlled and cannot be obtained by foreign agents in any very large quantity. There has been much discussion among N.F.P.A. members as to the best methods of combating this danger. The consensus of opinion seems to be that an intensification of the usual methods of fire protection is the only practical safeguard. Fire can be started in any one of a thousand ways which cannot individually be anticipated. But whatever the cause of the start of fire, the methods that have been found successful in peace time practice should be equally applicable. Limiting the amount of combustible materials exposed to any one fire, automatic sprinklers, fire alarms, watchman service and other standard fire protection measures, extended and intensified to meet the war situation, seem to offer the best solution of the problem.

* * * * *

Fire Prevention Week, 1939. Despite European war distractions, the observance of Fire Prevention Week, 1939, has been even more general than in previous years. It is now a thoroughly established annual institution which is recognized not so much as a week set apart by itself as the time for the intensive activity which furnishes the highlight of fifty-two weeks of fire prevention effort. Among the millions that participate only a comparatively small number, old N.F.P.A. members, remember the beginnings of the week in sporadic observance of Fire Prevention Day, and then its gradual evolution to its present status as International Fire Prevention Week. Hundreds of thousands have heard the eloquence of T. Alfred Fleming, popular fire prevention speaker, but few realize the extent to which he, as chairman of the N.F.P.A. Committee on Fire Prevention and Clean-Up Campaign since 1920, is personally responsible for the inspirational force underlying all this activity. His hearers recognize Mr. Fleming as an evangelist in the cause of fire prevention, but few know how he came to devote his life to this cause, how as a minister he happened to be near the Lakeview School in Collinwood, Ohio, during the tragic fire in 1908, personally rescued many children and helped remove bodies, and then and there resolved to devote his life to the prevention of similar tragedies.

The Michigan Electrical Law Decision. The Supreme Court of Michigan, in a recent decision, has declared unconstitutional the Michigan law which governed the installation of electrical wiring and equipment in the state and established machinery for securing installations in accordance with the National Electrical Code. This law was described in an article in the April, 1936, QUARTERLY by Mr. L. P. Dendel (member N.F.P.A.), Chairman of the Michigan Electrical Administrative Board. Mr. Dendel has given further information on the law and its operation in his reports to recent annual meetings of the Association as Chairman of the special N.F.P.A. Committee for Drafting a Model Electrical Law.

The court declared the law unconstitutional because the reference to the National Electrical Code as the standard of wiring constituted in the court's opinion an improper delegation of legislative power, the idea being that there is no authority under the Michigan state constitution to permit the legislature to adopt a law putting into effect future editions of the National Electrical Code as prepared by the N.F.P.A., which is a "foreign body" as far as the state of Michigan is concerned. The provision in the law which was referred to particularly by the court reads as follows:

> "The Electrical Administrative Board shall have general supervision of all such electrical wiring and shall, after not less than thirty days notice and public hearing, prescribe and publish minimum standards therefor, which shall be uniform and not less than the minimum standards prescribed by the National Electrical Code."

It is apparent from the reasoning of the court that not only this provision but any other form of reference to future editions of the Code would be similarly unconstitutional. It would thus appear that the legal device of putting standards into effect by making them prima facie evidence of safe and proper practice would be similarly unconstitutional.

The opinion of the Michigan Court was unanimous with respect to the unconstitutionality of this law, but the reasoning of the different members of the court varied. In the minds of certain of the justices the primary reason for declaring the law unconstitutional was an apparent discrimination in the wording of the law between different classes of users of electricity. While of interest in connection with the Michigan law, this point is one which could readily be taken care of in other legislation by a proper explanation of the reasons for applying different requirements to different groups of users.

While the Michigan decision applies specifically only to this one law, the principle would apparently apply to adoption by reference of any other national standard developed by the N.F.P.A. or any other organization. It does not necessarily follow that decisions in other states would be the same, but there is some background of similar court opinions elsewhere and it appears likely that the present Michigan decision may influence decisions in other states where similar legislation may be tested in the courts.

This decision seems to be a serious set-back in the general movement for the use of national standards in place of independently developed state and local legislation. It is indeed unfortunate that constitutional limitations operate to prevent the more general legal use of standards such as the National Electrical Code, which are nationally accepted as the established guide to safe practice and are generally agreed to by all parties at interest.

This decision does not apply to the similar adoption by reference of a specified edition of a standard. This plan is followed in many places, but involves the undesirable feature of requiring new legislation every time a new edition of the national standard is issued. In some cases this difficulty has been overcome by the establishment of a regular routine for revision of legislation at frequent intervals, changing the references to bring them up to date. Periodic revision of the Cincinnati building code, which adopts by reference a large number of established national standards, is a case in point. However, there are definite disadvantages to this plan. Every time such a legislative measure is introduced there is opportunity for political manipulation, and those interested in the maintenance of the national standard may thus be forced into almost continuous political activity in order to keep the successive editions of the standard in effect.

In some places it is still necessary when adopting specified editions of national standards not only to identify the standard, but to print it *in toto* with detailed enactment of all the provisions. This plan is even more objectionable, tending to keep obsolete standards in effect due to the difficulty of securing new legislation.

Curiously enough, the idea that delegation of legislative power to a so-called "foreign body" is unconstitutional does not seem to extend to a similar delegation of power to an agency of the state. There seems to be no objection to empowering a state fire marshal, board or commission to develop, promulgate and revise from time to time rules and regulations which have the force of law. States which operate under this principle leave their administrative officers free to adopt as state standards successive editions of the National Electrical Code or other national standards by going through certain formalities of adoption of each successive issue. This plan, however, puts upon the enforcing authority the burden of resisting all sorts of pressure from selfish interests for the adoption of standards differing from the national standard.

The Michigan decision leaves an unsatisfactory situation from the point of view of those interested in the promulgation of the legal use of national standards. It is to be hoped, however, that as time goes on this situation may be clarified and that in the slow working of American democracy some way may be found to put into effect the general desire of the interested public that national standards developed by competent and disinterested bodies such as the N.F.P.A. may be used without restriction where desired by states and cities.

Forest Fire Weather Forecasting.

By Roy Headley,
Chairman N.F.P.A. Forest Committee.

To say that forest fire danger cannot exist unless the amount and distribution of precipitation fall below a certain level is merely to state the obvious. Neither carelessness, incendiarism nor lightning can cause forest fires if rain falls with sufficient frequency and in sufficient quantity. The frequency and quantity of rain which will prevent danger of forest fires vary widely. Six hours of drying wind following a heavy rain may so completely wipe out the anti-fire effect of the rain that disastrous conflagrations may then occur in certain parts of the country. But the fact remains that wet forest fuels do not burn. The length of time that fuels stay safely wet after a soaking rain is controlled by other weather elements, principally wind and the varying moisture content of the air.

The effect of varying degrees of moisture in the air is familiar to everyone who has noted how long wet towels and clothes stay wet in humid weather and how quickly they dry at other times. Dry air sucks out the moisture from fabrics. If the moisture content of the air is high enough, wet materials never do dry out completely.

Likewise, dry air will suck out the moisture from forest fuels in an amazingly short time; also, the speed with which the lighter fuels take up moisture from the air seems incredible to anyone who is not familiar with instrumental measurements of moisture in wood and other forest fuels.

An experienced fire fighter expects that a fire will slow down with the coming of night and the accompanying higher atmospheric humidity. Usually a fire does just that—but not always. Sometimes the humidity fails to rise. Too often that means failure to capture a wild fire in time to prevent a catastrophe.

A forest fire control man must live with and work under conditions controlled by precipitation, atmospheric moisture and wind. Most forest fire wardens would probably agree that the most harassing of these three is the wind. Sudden high winds were the immediate cause of the loss of five lives in the 1939 disaster on the Toiyabe National Forest in Nevada, where fire danger is normally very low; 15 lives in the 1937 Blackwater fire on the Shoshone National Forest in Wyoming; and nearly 100 lives in the Idaho National Forests in 1910. Nearly every great historic forest fire has been driven by high velocity winds at the time of its greatest destruction of life and wealth.

The reports on larger National Forest fires, which are assembled and studied every year, show that with rare exceptions wind has played a decisive rôle.

In certain areas, as in the Angeles and San Bernardino National Forests in Southern California, it has become the accepted thing that serious fires will be avoided except during the occasional high velocity, low humidity winds which sweep in from the desert in the fall. If such high winds coincide with the carelessness of someone with a match, a cigarette or a pan of hot ashes, disaster is almost unavoidable. Despite low annual precipitation aggravated by a rainless period of six months or more during the late spring, summer and fall, together with a tinder-like watershed cover of brush and an extremely high human use of these two National Forests, fires can be and are either prevented entirely or stopped in their early stages—except when the wind is bad.

In other areas searing winds blow at times from the east or north with disastrous results if they find a forest fire to fan into a conflagration. Fire control executives dread these winds more than almost any other form of fire weather. They know that the only way to be sure that no conflagration results at such times is to impose emergency fire safety measures, such as closing down logging operations, closing areas to human use or warning people that emergency conditions exist.

In most forested areas west of the great plains, lightning is another dreaded element of weather. In that part of the country lightning storms often occur without any accompanying rain, or with so little that fires from that cause are not kept from spreading. These dry lightning storms are bad enough when they start one or only a few fires. When, as sometimes happens, one hundred and fifty or two hundred lightning fires are started in a single National Forest of one or two million acres, the task of mobilizing men, equipment and supplies and stopping the spread of all such fires is almost beyond the limits of human capacity.

Imagine a fleet of enemy airplanes dropping a hundred and fifty incendiary bombs within an hour or two on a modern city. Despite all the advantages of streets to travel on, water mains and well-distributed crews and equipment, the fire department would have its hands more than full.

Forest fire organizations have many comparative disadvantages in handling a crop of 150 fires from one storm. There are long distances to be traveled to reach the fires. Usually there is not even a trail for part of the way. Most of the force employed has to be recruited and organized for the job. All light for night travel through the woods and night work has to be furnished by lanterns and electric headlights.

But forest fire fighters have one important advantage. If they know when the lightning attack is coming and how severe it will be, almost any required

number of men may be recruited in advance, stationed at strategic locations and dispatched in groups as lightning fires are reported by lookout men. The equipment required is not so elaborate but that, if necessary, a thousand men can be mobilized and held at suitable points in readiness for instant action. But, of course, this cannot be done unless the fire control executive has reliable information on the severity of the impending lightning storm and when to expect it.

If the foregoing discussion of the importance to forest fire control of rain, atmospheric humidity, wind and lightning has been convincing, it will be easy to understand the importance of fire weather forecasting.

Weather doesn't just happen. Rain, wind, humidity, and fire-starting bolts of lightning are not the result of the whims of an irresponsible force seeking to bedevil us in our effort to restore our natural resources. True enough, these atmospheric forces come and go in an intricate pattern of variations and combinations which to the lay mind seems utterly detached from any ascertainable play of cause and effect. But the meteorologist knows better. He knows that the weather at a given moment in a given spot is the result of physical forces as definite as the force that makes an apple fall to the ground. He knows that if these causative forces could be precisely measured, fully understood and quickly analyzed, the occurrence of varying forms of weather might be predicted almost as definitely as the behavior of an apple when it becomes detached from the twig. The difficulty is to obtain the measurements of meteorological forces and acquire the needed understanding of how they act and react on each other to produce in due time what we know as weather.

Difficult as it may be to obtain the required meteorological knowledge and the men trained in fire weather forecasting, both must be provided if protection of forests and watersheds is to become more effective and more reliable.

The danger of fires is much more variable in forests than in urban areas. In the Southern States there is usually some danger every month of the year, but there are intermittent periods totaling a hundred days or more per year when fires will not spread, either because rain is falling or has fallen recently. In typical western and northern forests and watersheds there is in every year a continuous period of from three to seven months of no danger whatever, a total of from five to fifteen days when fire danger is at its explosive peak, and from 90 to 150 days when fire danger fluctuates up and down with the variations in weather.

Of necessity, fire control systems must be highly flexible. Broadly speaking, if a fire control manager knows positively a day or two in advance what the weather will be in specific portions of the area for which he is responsible, he can adjust the strength of his protective machine accordingly, almost as easily as an engineer can open or close the throttle on a locomotive. If he tries to operate with a wide open throttle all during the fire season his owners

quickly rebel at the expense. If he tries to operate continuously on an "average" throttle, he will be wasting time and energy, and interfering with other activities at times of low danger and have to take terrific losses under the impact of days of high or extreme danger. He must adjust and coördinate between the day to day degree of fire danger and the accompanying strength of the fire control organization. He is fully prepared to do this, providing only that he knows what the weather is going to be. He would like to have forecasts for weeks or a full season ahead, but lacking that he can do pretty well with reliable forecasts for only the coming few days.

When a dry spell occurs in the late spring in the West, the fire control manager needs to know if rain is coming. While the dry spell lasts he needs to know immediately of any coming period of low humidity, high winds or lightning. In early June, twenty years ago, unpreparedness on the part of certain western forest executives, coupled with drought and widespread dry lightning storms, destroyed vast areas of timber wealth and so damaged potential timber resources that the welfare of generations yet unborn will be adversely affected. Again, in the spring of 1939, a two-month drought of record breaking severity occurred in the same territory. The stage was all set for another disaster as in 1919. But this time localized short range weather predictions were available and were depended on. Losses were held down. Then came welcome and almost unprecedented June rains to give protection forces a breathing spell until the effect of the rain disappeared in July.

All through the fire season the fire control manager must know what weather to expect if he is to be a manager rather than a gambler. When will the relative humidity go down to dangerous levels and how long will it stay? Special measures must be taken while humidity is below a certain level. When will the winds strike and what will be their velocity? Extreme prevention precautions must be taken while they last, and subordinates must be told that if any fire should start during the windstorm they must "give the fire everything they have got." When will lightning storms come and how many fires will they start? What a real manager will do if a reliable forecast tells him to expect 60 lightning fires differs greatly from what he will do if the forecast says, "Expect six fires."

The manager of operations on a going fire, or "fire boss" as he is called in technical terminology, who undertakes his task without reliable weather forecasts is pretty helpless in his planning. If, on the other hand, he knows that a shower is expected or that the wind or the humidity will go up or down, that information will enable him to decide intelligently on the number of men and pieces of equipment to radio for. His orders for placement of crews around the fire, his instructions as to location of the fire line with respect to the edge of the fire and natural topographic features, his plan for safeguarding the lives of his men all depend on the weather forecast—or would do so if he had it.

In the Black Hills National Forest in South Dakota in July, 1939, a man-caused fire caused an estimated total loss of a half million dollars. If the man in charge had known that low relative humidity and high and variable winds would continue all through the first night of the fire, causing continuous "crowning" of the fire in the tops of the trees, there is a good chance that he would have so modified his management of the job that the fire would have been stopped at 2000 acres as against the 22,000 acres it finally covered. Fires nearly always stop running in the tops of the trees with the coming of night, thus affording an opportunity for more effective control operations. Infrequently, low relative humidity and high wind keep the crowns of trees blazing freely all night. The heroic measures required to stop the front of a crown fire are quite inappropriate if the fire will be influenced by normal night weather. Without reliable weather forecasts, the fire boss is merely a blind man taking chances, not a manager.

It often happens that a fire which because of wind and low relative humidity has been defying all control efforts, suddenly "lies down," goes out on much of its edge and barely creeps ahead where it has not gone out. Even veteran observers of fire behavior are often amazed that a running fire could so quickly change its nature. Such seemingly miraculous changes may be due in part to some unknown meteorological influence which persistent research will ultimately uncover. It is more likely, however, that such seeming magic is merely the result of changes in temperature, humidity and wind which, while not recognizable to human senses, are as conclusive in influencing fire behavior as an additional weight placed on one side of a pair of delicate scales.

At any rate, the fire boss needs the most reliable forecast of any such weather changes. There are instances where wholly excessive numbers of men and pieces of equipment have been assembled because of either an erroneous fire weather forecast or no forecast at all.

Fire control men have had a taste of the practical aid good fire weather forecasts can give them. In one important instance a fire weather specialist predicted a severe lightning storm in a certain portion of a ranger district. The Forest Supervisor accordingly assembled a considerable number of men and placed them in the best possible advance arrangement. The dry lightning storm came just as predicted, but as the result of the advance preparation not one single fire escaped to any serious size.

In a few National Forest regions frequent and localized fire weather forecasts are the regular thing. State, federal and association fire control officers traveling in automobiles can tune in their radios at certain hours and hear the forecasts going out to every remote fire warden, district ranger and fire boss, telling him just what weather to plan for during the next day or two. Special forecasts may be had upon request for any specific locality. In the region in

which fire weather forecasting has made the greatest advance, daring attempts are being made by forecasters of the Weather Bureau not only to forecast for specific areas of a few townships in size, but to be amazingly exact in such things as the severity of predicted lightning storms and the number of fires to be expected therefrom. When the adverse weather comes as predicted, the fire control manager has his forces organized and deployed accordingly—provided his previous experience has built up his confidence in the predictions.

In certain states the Weather Bureau has been able to provide "mobile units." Each unit consists of a truck in charge of a fire weather forecaster and crammed to the roof with the instruments and equipment required. Visit the base camp on one of the larger fires in the few states where these "mobile units" are available and you will find this outfit set up and operating. You will also find the fire boss anxiously awaiting up-to-the-minute weather forecasts before he lays his plans and issues his orders for the next shift of work. This will be true whether the fire is under Federal, fire control association or state jurisdiction.

The trouble with all this fire weather service is that it is neither as reliable as it might be nor as widespread as it needs to be.

It is not so reliable as it might be because the Weather Bureau of the Department of Agriculture cannot make reliable fire weather forecasts without adequate funds and facilities for research in this specialized field, an adequate number of stations recording and reporting the required meteorological data, and specialized personnel who have learned the subject and acquired skill in the art of this particular form of weather forecasting.

Vast areas which urgently need localized fire weather forecasts are without any such service except what can be supplied incidentally by general weather forecasters, who have to work with little or no special meteorological information from fire weather stations needed for this purpose.

Conflagration at Pine Ridge, Oregon.

By Oregon Insurance Rating Bureau,
(Member N.F.P.A.).

The huge plant of the Forest Lumber Company at Pine Ridge, Oregon, shut down for the week-end before noon on Saturday, August 19, 1939. In spite of the warm dry weather, with temperature around 80° and relative humidity in the vicinity as low as 12 per cent that afternoon, no watchman service was in operation. Several employees were engaged in the usual minor repair work in the sawmill and planing mill buildings. About 4:20 P.M. smoke was discovered coming from the adjacent lumber yard, and an alarm was given. The private fire brigade had drilled infrequently during the past two years, and a deplorable lack of organization for dealing with the emergency was apparent. The severe exposure from the burning of approximately 24,000,000 feet of high piled lumber in the yard proved too much for the sprinkler protection inside the severely exposed large wooden plant buildings in the path of the wind. These buildings were destroyed and the wind also carried burning planks across the Williamson River and destroyed the buildings of the lumber company's townsite. The fire spread for five miles through the forests until stopped at the shore of Agency Lake. The total loss from this conflagration was estimated at $2,000,000.

Property Involved.

The Forest Lumber Company property was a large lumber manufacturing plant with sawmill, dry kilns, planing mill, box factory, lumber sheds and lumber yard, and having its own townsite. The plant and townsite were located on opposite sides of the Williamson River at Pine Ridge, Klamath County, Oregon, inside the boundaries of the Klamath Indian Reservation. The company employed about 240 men in the operation of its manufacturing plant.

All major plant units with the exception of the dry kilns and planing mill fuel vault were of frame construction. The dry kilns alone were of fire-resistive construction.

The lumber yard, where the fire originated, occupied the center portion of the plant site, and covered an area of approximately 25 acres. The yard was built on level ground with fifteen alleys or trams running north and south between the piles of lumber, which were twenty-four feet in height. These alleys were intersected by four cross-alleys. Alleys were built of planking laid directly on the ground and averaged about seventeen feet in width. The crane shed, which was a part of the lumber yard, was a heavy frame building 79 ft.

by 450 ft., built on concrete piles. It had a corrugated iron roof laid on a one-inch deck and walls of one-inch rustic siding.

It is understood that at the time of the fire the yard contained approximately 24,000,000 board feet of lumber, mostly stuck piled. The crane shed contained another 4,000,000 board feet stored in crane unit packages or loads.

Fire Protection Facilities.

A two-water supply dry pipe sprinkler system covered all major units except the crane shed in the lumber yard, a small lath shed, machine shop and pump houses. Sprinkler protection did not extend to any of the company's townsite buildings. This sprinkler equipment was installed in 1926 following the erection of the plant. Hydrants were provided for all plant units including the lumber yard, as is shown on the plan. In the area of the lumber yard, where the fire originated, however, the number of hydrants was inadequate to provide good protection, and the hydrants protecting the townsite were for the most part on two-inch and four-inch pipe off a six-inch main. These facilities were supplemented in all of the manufacturing units by a good installation of inside standpipes and hose.

The primary water supply was provided by two 1500-gallon per minute centrifugal fire pumps, one steam and one electrically driven, drawing from the Williamson River, which separated the townsite from the main plant. The secondary water supply was a 100,000-gallon steel gravity tank supported by a 100-foot steel tower. A well-arranged, looped and gridironed system of eight- and ten-inch iron mains was provided in the plant area. This system was under good outside control from post indicator valves at sprinkler valves, pump tank, and loop connections. In addition, a full quota of water barrels and pails was provided throughout the lumber yard.

A private alarm system with six boxes, five of which were located about the plant and one at the company's hotel, was also provided. Alarms transmitted over this system were received at the plant's power house. Maintenance of sprinkler and other fire protection equipment is reported to have been good.

A fire brigade composed of plant employees was organized several years ago. Monthly drills were held at the outset, but before the fire drills had been infrequent. Watchman and clock service was maintained with hourly rounds nights, Sundays and holidays. It was not the practice, however, to have a watchman make rounds during the day when the plant was idle if a few men were engaged in making repairs about the plant.

Story of the Fire.

The fire was first seen as smoke rising from the lumber yard at a point about 150 feet south of the unsprinklered crane shed. Exactly where and how the fire originated is unknown. The first smoke rising from the fire appears to have been detected at about the same time by at least two persons, one the

Acme.

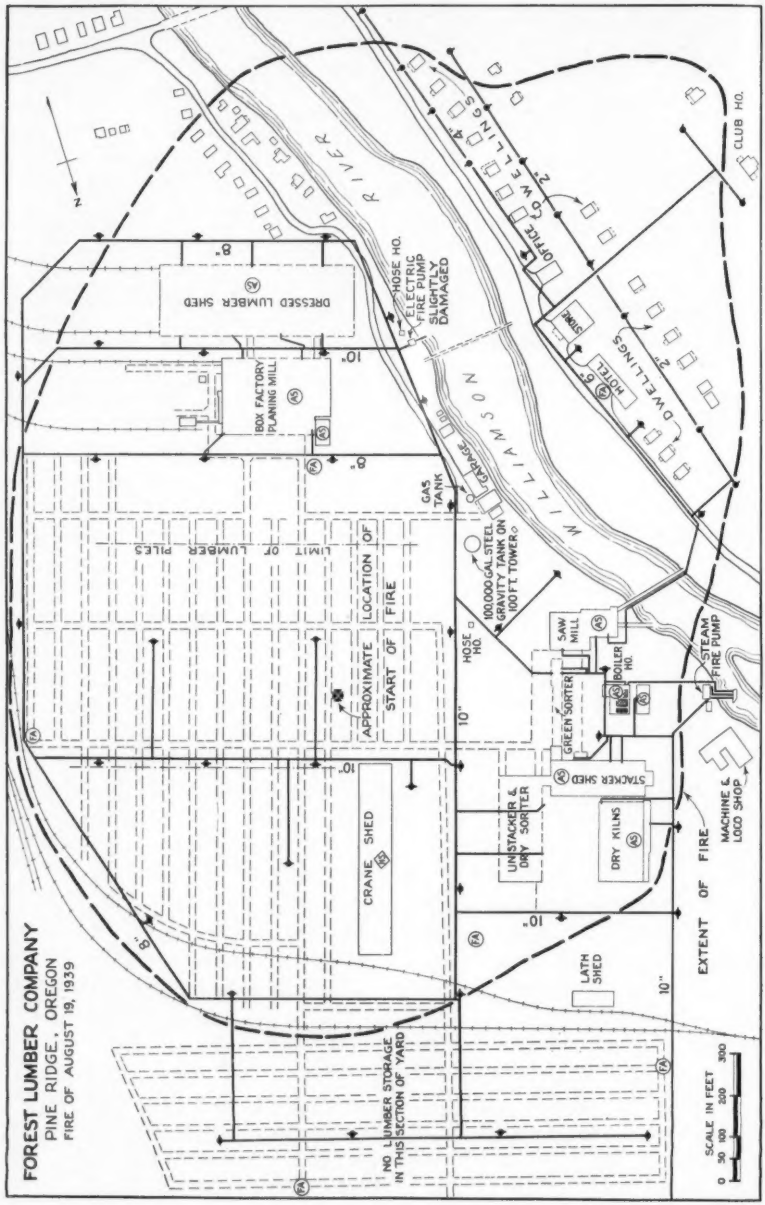
View of the conflagration which destroyed the Forest Lumber Company plant and townsite at Pine Ridge, Oregon, on August 19, 1939. A loss estimated at $2,000,000 resulted from the destruction of the large sprinklered plant, lumber piles and townsite buildings on both sides of the Williamson River. The blaze started a forest fire which spread for five miles to the edge of Agency Lake.

plant electrician, who was engaged with the repairs in the sawmill, and the other an unknown person who pulled the fire alarm box outside the entrance of the company's hotel in the townsite.

The exact time of detection is unknown, but it is generally agreed that it was about 4:20 P.M. Having observed the smoke, the electrician hastened to the power plant to give the alarm and was entering the building as the fireman on duty blew the fire whistle in response to the alarm from the box at the hotel. The electrician then hurried to a hydrant near the west side of the yard and east of the sawmill to pull out the hose. After the lapse of what he estimates to have been about two minutes, two men arrived to man the hose. With other men hurrying from the townsite, the electrician ran to the building housing an electric fire pump, which he placed in operation. The plant's steamfitter, who was in charge of the fire protection equipment, arrived soon after the fire whistle sounded and for the most part devoted his attention to the operation of the steam turbine driven pump.

Beyond the few details cited above, little could be learned of the methods used and steps taken to combat the fire. From the time the first men arrived in response to the alarm, a deplorable lack of organization was evident, and this lack of organization continued throughout the fire. Fire fighting was further handicapped by the fact that the plant manager was in San Francisco and many of the employees were away for the week-end.

According to the most reliable information available, only twenty minutes elapsed from the start of the fire until the crane shed burst into flames. The fact that the fire developed with such rapidity is accounted for by the high combustibility of pine lumber, its arrangement in 24-foot piles with stickers


FOREST LUMBER COMPANY
PINE RIDGE, OREGON
FIRE OF AUGUST 19, 1939
N
RIVER
WILLIAMSON
DRESSED LUMBER SHED
BOX FACTORY PLANING MILL
HOSE HO.
ELECTRIC FIRE PUMP SLIGHTLY DAMAGED
OFFICE
STORE
HOTEL
DWELLINGS
CLUB HO.
GAS TANK
100,000 GAL. STEEL GRAVITY TANK ON 100 FT. TOWER
LIMIT OF LUMBER PILES
APPROXIMATE LOCATION OF START OF FIRE
CRANE SHED
SAW MILL
BOILER HO.
STEAM FIRE PUMP
GREEN SORTER
STACKER SHED
UNSTACKER & DRY SORTER
DRY KILNS
MACHINE & LOCO SHOP
LATH SHED
EXTENT OF FIRE
NO LUMBER STORAGE IN THIS SECTION OF YARD
SCALE IN FEET
0 50 100 200 300

between, and the temperature and humidity conditions which prevailed at the time.

By the time the crane shed ignited, burning boards from the yard were being carried high into the air by the rising currents to drop elsewhere in the yard, among the plant buildings, and in the townsite across the river some 800 feet distant. Shortly afterward buildings in the townsite caught fire and soon many, including the hotel, company store and office, were in flames.

Within an hour from the start of the fire the sprinklered units of the planing mill, dry kiln and sawmill groups became involved, and in an hour and five minutes the pressures at both pumps dropped from 85 to 30 pounds. In the meantime, burning boards from the lumber yard set fire to the timber southwest of the townsite. Fanned by the northeast wind, the fire advanced with astonishing rapidity, climbed the timbered slopes of Steiger Butte, and then spread out fan-like to the shores of Agency Lake, five miles distant, which point it reached at about 6:15 P.M.

Conclusions.

Among the conclusions to be drawn from the fire which destroyed the plant of the Forest Lumber Company, the following are worthy of special mention:

1. It is an essential requisite that industrial properties, including large sprinklered plants depending upon a private fire protection system, should have a private fire brigade organization of trained men capable of coping with an emergency and available at all times.

2. There should be no deviations from the requirements of standard watchman and clock service calling for hourly rounds nights, Sundays and at all times when the plant is not in operation. The fact that men may be scattered about engaged in repairs should under no circumstances be considered equivalent to the patrolling of the plant by a watchman.

3. This fire likewise conclusively demonstrates the necessity of maintaining greater clear spaces between extensive lumber yards and other plant units, particularly where lumber is stored in high piles. It is evident that inside sprinklers are entirely unable to protect frame buildings seriously exposed by lumber yard fires unless greater separation between the yard and buildings is maintained.

4. It would also be desirable to have greater space between individual lumber piles, and as far as possible to separate lumber storage into less extensive fire areas.

5. Large lumber storage yards having high piling should, in addition to regular hose and nozzle equipment, be provided with heavy duty nozzles with sufficient water and pressure to break up the piles of lumber in case of necessity.

Bleaching Wood With Hydrogen Peroxide.

N.F.P.A. Committee on Manufacturing Hazards.

Two serious fires in furniture factories were reported during the first three months of this year, caused by the spontaneous ignition of lacquer residue following the use of hydrogen peroxide as a furniture bleaching agent. These fires, which were reported briefly in the April QUARTERLY,* *prompted the N.F.P.A. Committee on Manufacturing Hazards to investigate the dangers involved in the use of hydrogen peroxide for bleaching woodwork. The results of this study are given below.*

In order to produce a light colored finish on furniture and other wood products the wood is sometimes bleached, before finishing, with hydrogen peroxide (H_2O_2).

Solutions containing more or less hydrogen peroxide are applied to the wood by sponging, dipping, brushing or by spraying. The solutions used usually contain other chemicals, such as silicate of soda, caustic soda or sodium carbonate. It is said that some of these latter may be applied separately, before the peroxide, by some manufacturers. These additional chemicals probably regulate the speed, extent and depth of the bleaching action. Some of the bleaches on the market are divided into two separate containers, one containing the hydrogen peroxide and the other an alkaline or other solution to liberate the hydrogen peroxide and otherwise effect the process. These are mixed by the user.

Hydrogen peroxide is a powerful oxidizing agent, so bleaching, as in other bleaching agents, results from the oxidization of coloring matter. It may be used also in bleaching oils, wool, silk and some other textiles.

Pure hydrogen peroxide is not a commercial commodity, seldom being found outside of laboratories or like special uses. It is marketed, for medicinal use, usually in a 3% solution. Most of it used for industrial purposes is an aqueous solution containing 27.7% hydrogen peroxide by weight (30 grams per 100 c.c.). Probably about this strength prevails in most of the solutions sold for wood bleaching. Pure hydrogen peroxide is a colorless, bitter, rather thick liquid having a specific gravity of 1.458. It is miscible with water, ether and alcohol. It is produced by treating barium peroxide with an acid, but more generally by electrolytic process.

Hazards.

Hydrogen peroxide is not a hazardous liquid as compared with the volatile liquids to which the term ordinarily applies, but it is hazardous under certain conditions. If contaminated with various metals or their salts it may decom-

*See N.F.P.A. QUARTERLY, April, 1939, page 376.

pose with explosive violence. Being a powerful oxidizing agent, it releases free oxygen by catalytic action when in contact with certain metals, even though the metals themselves are not oxidized. Ordinary combustible materials, even though not finely divided, if coated or sprayed in whole or in part with hydrogen peroxide may oxidize, with ignition likely to result. The action is like an accelerated spontaneous ignition. Therefore, when hydrogen peroxide solutions are applied to materials which are inclined to ignite spontanously, such as paint rags, paint and lacquer deposits, certain metallic wastes, etc., spontaneous ignition is almost sure to follow.

Care should be taken, therefore, to guard any process where hydrogen peroxide, or a solution of it, is used, that the liquid may not be deposited on any waste material or combustible matter finely divided or in the form of small pieces or on paint residues and other such combustible deposits.

Serious fires have resulted from using a spray booth, ordinarily used for paint or lacquer spraying, for spraying hydrogen peroxide and from spraying hydrogen peroxide where the spray is deposited on floors, walls, benches, etc., covered more or less with paint or lacquer deposits. Lacquer and paint deposits left in a spray booth and its vent tubes and on the fans may soon ignite after contact with the hydrogen peroxide and, because of the added oxidization effect of the peroxide, the resulting fire is brisk, likely to be severe and difficult to extinguish.

Spraying hydrogen peroxide solutions should be avoided where possible, but if sprayed the process should never be conducted in spray booths which are also used for spraying lacquers and paints nor where other painting work is done. Application by brushes or sponges is advised.

A special booth, reserved solely for hydrogen peroxide spraying, should be provided where such work is necessary to regular production. For the occasional use of hydrogen peroxide solutions a special place should be prepared, located well away from painting processes and other processes when combustible refuse, finely divided metallic wastes and other such materials, affected by hydrogen peroxide, accumulate. Cleanliness is essential to safety.

Where the hydrogen peroxide is applied with sponges, rags, or by brushes, the work should be so conducted that the liquid may not be spilled or dropped on or near susceptible combustibles. Surplus liquid should be squeezed out of rags, sponges and brushes that none may be splashed or spilled. Used sponges and rags should be thoroughly rinsed in clean water and placed in standard waste cans or otherwise be promptly and safely disposed of. Brushes, after using, should be well washed out, placed in a covered safety container or kept in water.

Hydrogen peroxide is shipped from the producers in aluminum tanks on cars (tank cars), aluminum drums and some in glass carboys. On consumers' premises it may be found in various small containers bearing special trade

names. Where found in glass bottles, special care should be taken to avoid breakage. Large containers should have a safety vent. Steel containers should not be used. It is to be noted that hydrogen peroxide causes rubber to deteriorate. Such deterioration of the rubber hose which is a part of spraying apparatus might result in leakage of the chemical on materials affected by it.

In contact with the skin, hydrogen peroxide causes irritation, and prolonged exposure to its vapor is irritating to the eyes and lungs. In using it the eyes should be protected against splashing of the liquid by using safety goggles. Long rubber gloves should be used to protect the hands and arms. Prompt washing with water should follow any direct contact with the solution.

Fire Record.

The following record of fires where hydrogen peroxide was an important factor is given to indicate typical cases, and they show that extra precautions are necessary in using this liquid.

MARCH 11, 1937, LENOIR, N. C. A fire in a furniture factory occurred in a spray booth containing residues from spraying lacquer sealer or varnish, or possibly both, and the booth was also used for spraying hydrogen peroxide solution. Evidently the booth had not been thoroughly cleaned before using the peroxide solution. Residues took fire from spontaneous ignition. The fire was controlled by the operation of eight sprinklers. Loss about $5000.

JANUARY 31, 1939, THOMASVILLE, N. C. This furniture factory fire occurred under conditions similar to those above. Ninety-seven sprinklers operated and, aided by the fire department, controlled the fire. Loss was about $28,000.

MARCH 3, 1939, STAUNTON, VA. A fire occurred in a spray booth in the finishing room of a furniture factory. The booth was used for both lacquer spraying and for spraying hydrogen peroxide solutions. Spontaneous ignition occurred and the fire spread rapidly. The factory was of wood, metal-clad construction, and although equipped with automatic sprinklers the whole plant was destroyed except the detached dry kiln and lumber yard. The sprinklers opened, but the fire was too severe for the protection. Loss $455,000.

JULY 17, 1939, FORT SMITH, ARK. A fire in a furniture factory finishing department resulted in a loss of about $30,000. The fire occurred in the early afternoon of a very hot day (100° outside and possibly 110° in the finishing room). A standard spray booth used for spraying both hydrogen peroxide solution and clear lacquers alternately was being cleaned at the time between working shifts. Without prior evidence of fire, flames flashed out of the booth 25 to 30 ft. and the workman was severely burned. In the absence of electrical defects or other such cause of the fire, it appears clear that spontaneous ignition and rapid oxidization of lacquer residues by the hydrogen peroxide, possibly enhanced by stirring up the deposits in cleaning the booth, was the cause. Twelve sprinklers opened, which, with the use of chemical extinguishers also, extinguished the fire.

Smoke Hazards of Air-Conditioning Systems.

An investigation, including tests and research on practical and effective means of detecting and controlling the spread of smoke in air-conditioning systems and of reducing the possibility of smoke damage and panic hazard, was undertaken by Underwriters' Laboratories, Inc. (J. A. Neale, Protection Engineer), at the request of the National Board of Fire Underwriters.

A number of fires involving air-conditioning systems, and especially one in a large modern department store which caused extensive smoke damage to stock and which indicated possibilities of serious life hazard, pointed to the desirability of fire protection equipment for such systems that would be faster in operation than the usual heat-responsive devices, and suggested the use of controls operated by smoke detection. An important question is, are smoke detectors (photo-electric or otherwise) practical as a means for accomplishing the desired objectives in the protection of air-conditioning systems?

No attempt is made to answer specifically the question of under what conditions, or in what types of systems, or in what kinds of occupancies controls operated by smoke detectors may be needed. The investigation deals, in general, with the problem of practical means of controlling the smoke hazard in those situations where the maximum of protection is desired.

The investigation will, of necessity, concern itself to some extent with fire hazards of air-conditioning systems, since fires within the system will always be productive of smoke, although all smoke losses in which air-conditioning systems are involved are not attributable to such internal fires.

The problem may be divided into two general parts. First, when the combustion productive of smoke is within the air-conditioning system and, secondly, when the system serves to distribute smoke, fire and products of combustion from a fire exterior to the system, or, by its normal operation, increases the intensity of fire exterior to the system or interferes with its control by the automatic means provided for that purpose.

Fire Record.

In order to determine the facts in the case, an analysis of recorded fires of this type has been made. Information is taken as presented by the N.F.P.A. QUARTERLY of January, 1936, and April, 1938, and from other sources.

NOTE: This article appears in the QUARTERLY through the courtesy of the National Board of Fire Underwriters (Member N.F.P.A.). It is also available from the N. B. F. U. in separate pamphlet form.

Of 25 fires recorded, 19 involved combustion within the system. In seven of these 19 fires combustible ducts or interior duct linings were a factor, and in two fires exterior insulation of ducts was involved. Ten fires involved combustible or smoke-producing filters. In two cases combustible dust within the system is mentioned as contributory.*

In five cases no fire occurred within the system, but heat and smoke were distributed by it, and in one of these cases apparently neither fire nor smoke was carried through the ducts, but the air currents induced by the system (which was operating) contributed to the rapid spread of the fire in the building served by it.

Such loss figures as are available indicate that the average loss per air-conditioning fire is very high, approximating $22,000. Very fortunately these fires have almost invariably occurred at a time when the property involved was not fully occupied, so that injury and loss of life have not, as yet, been an important factor.

The number of fires recorded is not large enough to warrant great reliance for detailed statistical purposes, and it is quite probable that, due to the lack of experience with the behavior of these fires and with the materials and devices employed, the facts have not been properly interpreted by the observers in some cases. However, the record may safely be accepted for what its general trend indicates.

It is indicated by the record that a considerable proportion of fire and smoke losses occurs from combustion within the system. The elimination of combustible or smoke-producing materials and appurtenances, and frequent cleaning will alleviate this condition, as also will the elimination of possible sources of ignition, but these measures cannot be expected to correct it entirely. Materials whose combustibility or smoke-producing properties would be considered negligible in an open room may become seriously hazardous under the draft conditions generally prevailing within the duct system, and, even though the system is not operating, the drafts induced by stack or chimney action may be quite vigorous and may be especially so at the time of a fire.

Fundamentals of Protection.

It is obvious that the maximum in fire protection should be provided in those systems which are in buildings containing large numbers of people or large values in materials subject to damage by fire and smoke. The extent of the system and the importance of the fire-resistive walls and floors pierced must also be considered.

Air-conditioning systems vary so greatly in size and arrangement that no one plan of protection can be expected to apply to them all. Each system will require study so that the protective features can be suitably adapted to it.

*Unit air filters listed by Underwriters' Laboratories, Inc., are now available.

A characteristic of fires of this type is the rapidity with which action progresses. This point can hardly be overemphasized. Naturally, a correspondingly rapid action of the detecting and protective devices is necessary.

In the event of fire occurring in an air-conditioned building, either inside or outside of the duct system or in the vicinity of its intake, the following actions are fundamentally necessary:

1. Shut down the blowers so that the movement of air will not augment the fire.
2. Interrupt the continuity of the duct system (by dampers) so that smoke, flame and heat may not travel from their source to the places where damage may be caused.
3. Isolate and extinguish the fire.

From the foregoing it is obvious that blowers should be stopped and dampers closed when there is:

1. Smoke or fire in the air-conditioning system, or,
2. Fire elsewhere in the areas served by the system.

In air-conditioning systems the problem of affording fire protection, by which we mean protection from smoke as well as from flame, is complicated by the fact that smoke in the system is not necessarily accompanied by heat, and consequently the customary methods of detecting fire and initiating its extinguishment by thermal means are not necessarily applicable.

A further explanation of this condition may be made. It is quite possible that an air-conditioning system may distribute smoke from a fire outside of the building when the smoke is drawn into its intake, also smoke from a fire in the building served may be drawn through the return ducts and discharged to other sections; in neither of these conditions can we be certain that heat enough to operate thermal devices will be carried along with the smoke. It is also very likely that heat from a fire within the system itself will be so diluted by the high velocity air stream into which it is passed that the resulting temperature will not be high enough to operate a thermal device, which must necessarily have an operating temperature high enough to prevent premature operation from the heat conditions incident to normal operation of the system. Fortunately there are means of quickly detecting the presence of smoke even in very small amounts, and these seem adaptable to our purpose.

Smoke Detecting Equipment.

There are numerous means of detecting smoke. Devices employing the photo-electric cell seem to be best adapted to the purpose at the present time, and several concerns are developing equipment of this type. We may expect these devices to be submitted to Underwriters' Laboratories, Inc., in due course, and their tests and examination will cover the electric and mechanical details of the device itself. In what part of the duct system it should be installed and how sensitively it must be adjusted so as to operate when it should and yet be

free from false alarm operations are interrelated matters which will, of necessity, be finally determined by observations of the behavior of such devices installed in actual equipments or in test equipments constructed for this purpose.

It must be definitely realized that, unlike a fire detecting device, the smoke detector, when used, should not be employed to actuate the discharge of water, foam, gas, or other extinguishing mediums. It should be limited to stopping blowers, sounding alarms and closing dampers. There is always the possibility that it may operate when smoke is drawn into the system from an outside source, there being no fire in the system to extinguish. This feature of the smoke detector is proper and desirable, and should not be considered as a "false alarm." Cases are recorded where smoke detectors have shut down air-conditioning systems when wind has carried smoke from near-by stacks into their inlets, and have thus prevented the circulation of this smoke in the conditioned premises.

Location of Smoke Detecting Equipment.

The smoke detector must be located where it can supervise all of the air passing through the duct system. In some systems it may be necessary to install more than one such device to perform this function.

It would seem desirable in most cases of conventional system design to locate the smoke detector immediately downstream from the blower and filter. It will then be in a position to immediately detect smoke originating at the most hazardous part of the system (the filters, the heating and cooling equipment, the electrical equipment, etc.). At this point the stratification of smoke in the duct will be at its minimum, and also at this point the air, being normally clean and tempered, will have the least deteriorating effect on the lenses and reflectors of the smoke-detecting device.

To retard fouling, lenses and reflectors should not be directly in the air stream. They should be set back from the sides of the duct and should be readily accessible for cleaning and inspection. In some installations precautions must be taken to prevent condensation on the lenses or reflectors.

Sensitivity of Smoke Detecting Equipment.

This feature involves a compromise. We desire a sensitivity great enough to detect the faintest trace of smoke, but, on the other hand, not so great as to institute false alarms:

Among the features tending to cause false alarms are:

1. Voltage variations on the light source circuit.
2. Decreasing brilliancy of the light source due to age.
3. Fouling of the lenses and reflectors.
4. Loss of efficiency of the equipment amplifying the photocell output, if such is used.

As these conditions, except No. 4, progress, they increase the sensitivity of the equipment, as they all reduce the amount of light falling on the photocell so that less additional interference by smoke is necessary to reduce the light intensity to the operating point. It will probably be practicable to design the devices to compensate for most of these features.

Experiments that we have made indicate that the photo-electric cell is highly sensitive and rapidly responsive to interferences caused by small amounts of smoke. Our experiments further indicate that black or white smoke issuing from a duct in quantities that are just perceptible to the eye will produce a drop of about 5 per cent in the photocell output, and that quite perceptible discharges reduce the output 20 or 30 per cent.* Naturally, we may assume that at the outset of the fire the volume of smoke will be very small and that it will rapidly increase so that the sensitivity becomes, for all practical purposes, a time factor.

It would seem, then, that a drop of 5 per cent is about as fine a setting as need be required and that a much greater drop will ordinarily be experienced when there is fire, or smoke from a fire, in the system. However, before setting definite limits, we should know more regarding the ability of the photo-electric equipment to compensate for the deteriorating influences which will develop between maintenance inspections. Experience with test installations indicates the ability of the devices to function properly for several weeks at a time under ordinary conditions without cleaning lenses or reflectors or other servicing.

Some systems have several return ducts or by-passes which would dilute smoke coming from any one of them. This will require special consideration of operating sensitivity of the smoke detecting equipment.

Use of System as Smoke Ejector.

The idea has been suggested that, with some changes in design, an air-conditioning system could be arranged so as to reverse its flow at time of fire and eject smoke and products of combustion from the building.

Investigation indicates that very few systems could be so arranged except at a cost that would be prohibitive, and a further study of the matter casts grave doubts on the advisability of such an arrangement.

Ventilation of burning buildings is a fire department operation, requiring the exercise of considerable judgment if favorable results are to be attained. It should not be attempted until ample extinguishing facilities are in readiness.

There is considerable hazard introduced in drawing fire and smoke into the duct system, in that smoke and fire may be communicated to other parts of the premises, and combustion within the system may increase the loss.

*Note: The measurements referred to apply to a photocell whose output is directly proportional to the intensity of the light it receives.

While an installation may occasionally be found that lends itself to this use, the complications are such that very serious consideration should be given to the various hazards involved before such a plan is recommended.

Dampers.

It is somewhat doubtful if the usual types of dampers now provided for normal system operation will be entirely suitable as smoke and fire stops. A high degree of tightness is not an important factor in the regular operation of the system, and many dampers of the louver and vortex type will permit the passage of considerable air when in the closed position.

Dampers for fire and smoke control should close the duct tightly, should be held securely when in the closed position, and should be so constructed that exposure to heat will not cause warping or derangement that would defeat the purpose of its tight closure.

There is apparently no reason why dampers cannot be so constructed as to perform satisfactorily in the normal operation of the system and also as fire stops, and this would be desirable from reasons of cost and conservation of space.

Damper Closing Mechanism.

Damper control mechanism, mainly electrically or pneumatically operated, is in general use, which performs satisfactorily and reliably. It is adapted to automatic or manual control or both. Many of these mechanisms, either with or without modification, will probably be found upon examination to be suitable for operation of fire dampers. When so used, however, they should be so arranged that failure of any part of the mechanism or the power supply will return the damper to the "safe" or closed position.

Location of Fire Dampers.

The strategic location of fire dampers within the duct system, arranged so as to be closed automatically by a smoke detector, will limit the spread of smoke or fire.

Under certain conditions in systems of conventional design, fire dampers operated by the smoke detector may be desirable in all ducts entering or leaving the central enclosure containing the air-conditioning equipment. These dampers are in addition to the thermally operated fire shutter required at the outside air intake opening to protect against exterior exposure and those required at the intake and outlets of ducts that serve more than one story. However, a smoke damper need not be installed on the fresh air intake where it enters the central enclosure unless the fresh air intake supplies more than one system.

Under some conditions, when the central enclosure may contain considerable combustible material, it will be desirable to allow a vent to the outside air for the products of combustion. In such cases, if a shutter is provided

on the intake to keep out cold air when the system is not operating, arrangements should be made to open this shutter in event of fire in the central enclosure.

In most cases it will be feasible to have the fire dampers close automatically each time the system is shut down and remain closed while the system is not operating. Such an arrangement is very desirable. Frequent operation of the shutters will render them more likely to be serviceable when the emergency arises, the system will not be able to conduct fire or smoke freely throughout its length when not operating, and the arrangement for automatic operation at time of emergency will be simplified.

It is contemplated that smoke detectors will be in service when the system is shut down as well as when it is operating, as serious fires have occurred when the systems have been shut down, and alarm service is desirable at such times.

There will be found complicated systems where considerable ingenuity may be required to accomplish the isolation of the various parts of the duct system with any reasonable number of dampers, and each of these will have to be handled as a special case. Return or supply ducts of considerable extent which open into more than one fire division or floor may require subdivision by additional automatically operated fire dampers in order to limit the area affected in event of fire or smoke in that particular duct. This will be determined by consideration of the panic hazard or property damage in each case, and also by the effectiveness of the thermally operated fire dampers which are required by the N.B.F.U. Regulations* on all inlet and outlet openings on such ducts. Fortunately, the trend of the industry seems to be away from the large complicated systems, whose extensive ducts pierce numerous fire walls and floors, and toward the unit system in which numerous separate small systems are installed, each serving the area in its immediate vicinity, with little duct work and affording no intercommunication between fire divisions.

Recommended Sequence of Operations at Time of Fire.

It is contemplated that in cases where maximum protection is desired, the automatic protective operations will be initiated by the smoke detector or by a sprinkler water flow alarm, an automatic or manual fire alarm originating in the premises served by the system, or manually. An alarm will be sounded, either locally or at the central station of a protective signaling system, as the case may be. Power will be simultaneously cut off the blower. The fire dampers will be closed with such time retard as may be necessary in the particular system under consideration to prevent collapse or bursting of ducts. If fire is in the duct system, heat arising from it will, now that movement of air has been stopped, operate the fusible links, permitting dampers at fire wall openings and duct outlets to close; will open automatic sprinklers installed at

*Developed by N.F.P.A. Committee on Air Conditioning.

filter banks; will operate thermal devices, discharging foam or gas on filter oil tanks; or operate such other heat devices as may be installed in that part of the system which is involved.

It should be borne in mind that thermally operated equipment is at a distinct disadvantage when located in high velocity air currents. However, when the blower has stopped and the sectionalizing dampers closed, the movement of air has ceased. The heat from the fire will now be localized in the section of the system involved and conditions will have become very favorable for the prompt and proper operation of the thermal devices.

Unless it is considered feasible to install sprinklers or other protective devices throughout the ducts, any fire in the ducts themselves will necessarily be extinguished by manual means.

Practical Application.

A protective system embodying the principles previously discussed has recently been installed in a large modern department store. The property is completely sprinklered and has complete central station protective signaling system service, including waterflow and sprinkler supervisory, night watch and manual fire alarm services.

Description of Protection.

The protective features are applied to three air-conditioning systems.

The two larger systems are equipped with smoke detectors of the photo-electric type located in the main supply ducts just downstream from the blowers. Tight fitting louver type dampers are located in each return duct where it enters the plenum chamber, and also in the main supply duct immediately upstream from the blower.

The third and smallest system circulates air in the sub-basement and has no filters or dampers, and performs no conditioning functions. This system is equipped with a smoke detector.

When smoke is detected in any system, the blowers on all three systems are automatically shut down, the fire dampers are closed, and local and central station alarms are sounded. The same protective functions are initiated by operation of a manual fire alarm box or by the operation of the water flow alarm of the automatic sprinkler system.

Description of Devices.

SMOKE DETECTOR—The smoke detecting devices are of a type being developed for operation in connection with central station protective signaling systems. They are, briefly, an adaptation of a light source and a photo-electric cell arranged to actuate a relay when the illumination falling on the cell is reduced as by smoke. The sensitivity is adjustable, and variations in the voltage supplying the light source are compensated for. Power failure, burnout

of light source and circuit derangements will sound a trouble alarm entirely distinct from the smoke alarm. This device operates through relays to interrupt the current in the holding coils of the fan motor starters, thus shutting down the fan motors when smoke is detected.

DAMPERS—The fire dampers are of the louver type, substantial and close fitting.

DAMPER CLOSING MECHANISM—The dampers are held in the open position by spring loaded pneumatic pistons, controlled by an electro-pneumatic valve actuated from the circuit supplying the blower motor. When the blower is shut down, the air pressure is released and the spring action closes the damper. When the blower is started, air pressure overcomes the spring pressure and the damper is opened and held open so long as the blower is running. Power failure or failure of the compressed air supply will close the dampers. The closing mechanism is adjusted to close the dampers slowly (3 to 5 seconds), and weighted relief dampers in the duct wall will act as relief vents momentarily after the blower has stopped and the dampers closed, to prevent rupture or collapse of the duct.

The fire dampers are normally closed whenever the system is not operating.

TESTS OF OPERATION—The sensitivity of the smoke detectors was measured by inserting into the light beam transparencies having a known interference to light transmission. The three smoke detectors are installed in parallel, and the sensitive relay is normally adjusted to operate when interference to the transmission of light in any beam reduces the photo-electric cell output by 2½ microamperes. This drop corresponds to a reduction of about 10% in light transmission.

No detailed examination or tests were conducted on the dampers or the damper closing mechanism, as this equipment is of a type that is in general use in air-conditioning and related equipment.

SMOKE TESTS—Smoke tests were made on all three systems. Smoke was developed by burning yellow smoke bombs in a bucket and permitting the smoke to be drawn into the suction side of the system through an opened door in the duct. In all cases the smoke was present in considerable volume and density. Each system operated promptly and as intended. On each test the alarms sounded, all blowers stopped and all dampers closed. Observers in the floors above reported that no perceptible smoke appeared until the systems were restarted after the test to purge them of the smoke in the plenum chamber.

OTHER TESTS—The air-conditioning protective system was tested by operating a manual fire alarm box and a water flow alarm, and operated as intended in each case. Various signal circuit derangements were simulated and trouble alarms were received as intended.

Note: Air velocity through light beam in largest system was in excess of 3000 feet per minute.

Remarks.

Effective means of detecting and controlling the spread of smoke in air-conditioning systems is especially necessary in premises where the panic hazard is pronounced or where the probability of smoke damage to contents is considerable.

Suitable equipment for reliably and practically accomplishing this purpose is available, and nearly all the devices necessary (excepting the smoke detector) are those generally used for the normal operation of the systems. The cost of providing such protection may be considerably reduced if the system is originally designed to incorporate such protection.

Chicago Elevator Explosion.

By David J. Price and Hylton R. Brown.*

A dust explosion and spectacular fire at Chicago on May 11, 1939, caused the loss of nine lives, more or less serious injury to about 30 men, and a property loss of about $3,500,000. The initial explosion occurred about 8:52 A.M. in Calumet Elevator A, owned by the Chesapeake & Ohio Railroad Company and operated by Rosenbaum Brothers. The fire which followed spread to Elevator B, also known as Elevator A Annex, and to Elevator C of the Rosenbaum group, and then jumped across a slip and ignited two other elevators operated by the Norris Grain Company. All elevators were located along the Calumet River between 102nd and 103rd Streets. The elevators were built in 1894 and 1895 and were of the old style metal-clad, frame construction with crib bins. The destruction of the five wooden elevators and their contents was almost complete. A section of concrete grain storage tanks alongside Elevator A and portions of brick buildings formerly used for power houses, when the elevators were operated by steam, remained standing. Only a small amount of the grain in storage was salvaged.

Description of Plant.

The line drawing shows the arrangement of the buildings involved in this explosion and fire. Many changes and improvements had been made since the buildings were constructed, particularly in providing additional fire protection

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Note: The July, 1939, QUARTERLY contained on page 33 an account of this Chicago Elevator conflagration extracted from a report published by the Chicago Board of Underwriters in collaboration with the National Board of Fire Underwriters and containing details on the progress of the fire and fire fighting operations. The present report contains information not previously published as to the possible cause and origin of the disaster.

Calumet A Tanks
Calumet Elev. A
Calumet Elev. A Annex
Calumet Elev. C
Freight Cars Burned
Direction of Wind
N
Pumpers Drafted Here
Slip No. 2
Start of Fire
190'
100'
Gravity Tank
835'
Extent of Fire
Norris A
Norris B
570'
Marshy Land
Roadway
Piles of Railroad Ties Burned
ROSENBAUM BROS., INC. & NORRIS GRAIN CO. ELEVATOR FIRE
Chicago, Ill. May 11, 1939.
Scale in Feet
0 100 200
Crooks Terminal Warehouse
Pumpers Drafted Here
Slip No. 3

during recent years. Automatic sprinklers had been installed, and provision made for water curtains on the exposed sides of the Calumet Elevators. The Norris Elevators were not provided with sprinklers.

The concrete storage tanks were erected in 1930 and were connected to Elevator A by concrete belt tunnels at the basement level and by steel frame, metal-clad belt galleries at the level of the top of the tanks, as shown in the drawing. Guillotine doors operated by fusible links were provided to prevent the spread of fire through the tunnels.

Electric power had replaced steam power in the elevator plant, and the old boiler equipment had been dismantled. The boiler house was used for shop work and to house the fire pumps. Electrical equipment was probably well above the average, with wires in conduit, vaporproof lights, and dustproof and non-sparking motors. Dustproof switch and fuse cabinets were generally used. Squirrel-cage motors were used in the concrete tank section, and some old style fuse cabinets had not been replaced. Motors were grounded.

Elevators A and B were connected by a steel frame, metal-clad belt gallery for the transfer of grain from one house to another, and Elevators B and C were connected by a concrete belt tunnel for the same purpose.

Equipment in all houses was largely of wood. Scales and garners were of wood. Elevator legs and heads were of wood, but boots were of metal.

A grain drier with brick walls about three stories high was located east of Elevator A, as shown on the drawing. It was connected to Elevator A by several spouts and a frame-enclosed belt gallery or tunnel at the ground level.

A metal-clad, frame dust house located east of the drier also was connected to Elevator A by spouts or ducts from the cleaning floor located about the middle of the bins in the southeast corner of Elevator A. Fans on cleaners, clippers, and separators located in this cleaning room discharged to the dust house. Floor sweeps in Elevator A connected to a fan on the first floor which discharged to the dust house.

East of the concrete storage tanks was a truck dump arranged to receive grain brought to the elevator by trucks. In this sheet metal building was installed equipment to lift trucks and discharge their grain into a hopper connected by conveyor belts with the belts in the basement of the storage tank section. Two of these belts were operating in concrete tunnels.

Story of the Explosion and Fire.

Information available indicates that the men had reported for work about 8:00 A.M. and were engaged at their regular duties when the explosion occurred. One elevator employee was in charge of the truck dump, east of the concrete tanks, where grain delivered to the elevator by motor truck was unloaded. He was seriously burned and died in the hospital the next day. Nine other men were working in Elevator A, eight of whom are believed to have died in the

Crack in the concrete wall at the east end of the concrete storage tanks due to propagation of the explosion from the basement of Elevator A through tunnels to the basement of the concrete tanks and upward through the steel leg and its concrete enclosure.

explosion and fire. One employee escaped, but he was seriously burned and had been caught under falling débris at the east end of Elevator A. He was rescued by workers from other parts of the plant and taken to the hospital. Two bodies were recovered and identified. Parts of other bodies were recovered, but at the time this article was prepared all had not been identified.

From the superintendent of the elevators, the foreman and the employee who escaped, information was obtained concerning the operations in progress in Elevator A at the time the explosion occurred. Neither the superintendent nor the foreman was in the elevator at the time, but they described the operations they believed were being carried on. These operations may be described as follows:

1. The day before the explosion occurred several truck loads of corn arrived at the elevator. All but one had been unloaded on the truck dump east of the concrete tanks by quitting time. When operations were resumed the

next morning six elevator legs—Receivers 1, 2 and 3, and Shippers 3, 4 and 5—were started in Elevator A; the conveyor belts from the truck dump to the basement of the concrete tanks and through the tunnel to Shipper 4 were started and the truck load of corn held over from the day before was emptied. This corn traveled over the conveyor belts to the boot of Shipper 4, was elevated, weighed and spouted to a bin. As far as is known, no distributing belts were operating in Elevator A. This particular grain handling operation had been completed prior to the explosion, because the information available indicates that the trucker, after unloading at the dump, drove to the elevator office where he was advised of the weight and had left the premises.

The elevator employee in charge of the truck dump had shut down the conveyor belt leading from the dump into the concrete tank section and had entered the basement of the tank section to shut down the belt which carried the grain through the tunnel to the boot of Shipper 4 in the basement of Elevator A. His statements before he died and the evidence available indicate that he was at a point under the tanks along the north side and about one-fourth of the length of the basement from the east end. Rescuers found him on the roadway along the north side of the tanks, and he indicated to them that he had just shut down the belt leading to Shipper 4 when the explosion occurred, and that he had climbed out of one of the basement windows. The condition of the conveyor belt noted by the investigators indicated that it had been stopped before the explosion occurred. The control button for this belt was along the north wall of the tanks, where the employee stated he had been standing. He evidently selected the basement window as the quickest means of escape from the building when the explosion occurred and enveloped him in flames.

2. On the day before the explosion some wheat was transferred from Elevator B to Elevator A and a part of this lot of grain was held in the upper cleaner bin. As described previously, the cleaning room was located about halfway between the ground floor and the top of the bins at the southeast corner of the bin section; the portion of the original bin above this room was known as the upper cleaner bin, and the portion below the room was known as the lower cleaner bin. At the time the explosion occurred the grain which had been held for cleaning was being run through the cleaner into the lower cleaner bin, and from it to the boot of one of the shippers which elevated it for distribution to designated bins. The bin foreman was the man who arranged for the distribution of this grain to a designated bin, and he is listed as one of the men killed in the explosion. Information concerning the arrangements for this grain transfer was not available to the investigators. Information concerning the shipper leg used to elevate the grain from the cleaners was confusing. It was indicated that either Shipper 3 or Shipper 5 could be used and both were running.

General view of the Chicago elevator conflagration from the northeast after all five elevators were involved.

3. Some sweeping was being done at the southeast corner on the first floor of Elevator A. The foreman stated that when he passed through the first floor of Elevator A a few minutes before the explosion, on his way from the office building west of the elevator to the millwright's shop, located between Elevators B and C, two of the employees were sweeping or cleaning up around Shipper 5. The statement of the employee who escaped from this section of the plant checks with this information. He advised the investigators that he was sweeping on the east side of Shipper 5 and another employee was sweeping on the west side of the leg. He stated that the first flash of fire came out of Shipper 5. It is assumed that one shipper leg was used to elevate the clean grain from the cleaning operation described under 2, and another leg was used to elevate the screenings from this operation and the material swept up on the first floor.

Operations in other sections of the plant, particularly Elevators B and C, had no bearing on the cause or origin of the explosion. Although some grain handling operations were in progress in these houses, the explosion did not propagate to them, and it was some time before they were ignited by the fire which followed the explosion in Elevator A.

Some repair operations were in progress in the drier building directly east of Elevator A, but the two men engaged in this work escaped without being burned or injured.

The dust house located east of the drier was not involved in the original explosion. One man was at work in the building, according to information furnished the investigators, and he escaped without injury.

There was evidence to indicate that the explosion propagated from the basement of Elevator A, through the tunnels to the basement of the concrete tanks, and upward through the steel leg and its concrete enclosure at the east end of the tanks. One of the photographs illustrates the damage caused by the pressure in this section.

Origin of the Explosion.

From the evidence obtained in an inspection of the ruins and statements of employees, it is believed that the explosion originated in the boot of Shipper 5. This leg may have been handling screenings from the cleaners. The fact that the men on the first floor were sweeping into this boot would indicate that a certain amount of dust was present in the leg.

The tunnel through which the conveyor belt ran from the basement of the concrete tanks to the boot of Shipper 5 was examined as far as possible from the tank end and was found to bear more evidence of fire than could be noticed in other tunnels. Charred dust on the curved concrete wall where this tunnel entered the tank basement indicated that the flames propagating from the basement of Elevator A were deflected toward the east end of the tanks, where they entered the steel leg and its concrete enclosure. Of course there was some flame propagation in other directions, but the evidence would indicate that the principal paths of travel were northward through the tunnel from the boot of Shipper 5, westward through the first floor of Elevator A, and upward to the cleaner room and through the leg to the upper floors of Elevator A.

Possible Causes of the Explosion.

Although there was considerable evidence that the cause of this explosion may have been associated with the unloading of the truck load of corn at the truck dump east of the concrete tanks, it was not possible to establish this operation as the most probable cause. It was assumed that foreign material in the corn might have caused a spark when it entered the conveying and elevating machinery. It was suggested also that the truck in starting may have backfired and ignited dust which fell on to the conveyor belt and was carried into the elevator. Electric sparks from the motors or starters on the conveyor belts from the truck dump also were cited as possible causes. The fact that the truck dumping operations had been completed sufficiently long before the explosion occurred to permit the weighing of the load and the delivery of the weight ticket to the driver at the office, and the fact that he had left the premises precluded the establishment of these possible sources of ignition as the most probable cause of the explosion.

The complete destruction of Elevator A and the fact that the débris had not been completely cleared away while the investigators were on the ground made it impossible to determine the condition of equipment in which the explosion is believed to have originated. With the lines of propagation centering at the boot of Shipper 5, it is believed that this part of the grain handling equip-

ment was the point of origin, and the most probable cause of the initial ignition was foreign material entering the boot either from the cleaners or from the work floor.

Conclusions and Recommendations.

All the elevators involved in this explosion and fire were of the old style wooden type, which made it impossible or impractical to comply with many of the suggestions in the terminal grain elevator safety codes. Unusual precautions had been taken for the prevention of fire, but this case demonstrated again that an elaborate sprinkler system can be rendered useless by an explosion. It is believed that it might have been possible to provide some protection in Elevators B and C if power could have been maintained at the fire pumps and control valves to cut out the damaged sections had been available. Where sprinkler systems are subject to the explosion hazard, it is suggested that underground power lines to the pumps be provided and that remote control valves be installed to cut out damaged sections of sprinkler piping.

The increased use of motor trucks for the transportation of grain, and the hazards incident to their operation in dusty atmospheres, emphasize the need for further study of this problem. In some cases it is known that tilting of the truck to unload the grain may cause gasoline to spill from the tank or carburetor. After long runs with heavy loads the exhaust pipe and muffler of trucks may be hot enough to ignite dust. A backfire when the truck is started after unloading would be capable of igniting dust deposits around the dump. If this method of grain handling is used at an elevator, it is recommended that all possible precautions be taken to eliminate the sources of ignition mentioned.

The regulations which prohibit the application of suction before weighing grain entering an elevator prevent the elevator operator from providing adequate protection. Foreign material in grain received at an elevator is frequently of a type which may produce sparks if it enters the grain-handling machinery. Dust accumulated in the grain during previous handling operations must be received into the house with the grain and weighed. It is suggested that attention be given to the possibility of developing some system whereby dust removal during the handling of grain could be under supervision to prevent abuses. Dust could be caught in a bag and the bag included with the shipment where it is necessary to maintain weights. Some provision must be made to remove the incentive for elevator operators to return to the grain the dust removed during handling operations in order to maintain their incoming and outgoing weights. It will be necessary to develop and install effective methods for dust collection and dust control in grain elevators in order to reduce dust explosion losses in this industry. Until this is done it will not be possible to make progress in dust explosion control in terminal grain elevators comparable with what has been already accomplished in the control of the dust explosion hazard in other grain and milling industries.

Weymouth Art Leather Company Fire.

Report by Eastern Underwriters Inspection Bureau,
(Member N.F.P.A.)

The severe hazard of intense, fast spreading fires in plants handling cellulose nitrate materials, and the imperative need in such plants for the segregation of hazards into small areas by positive fire cut-offs, special forms of sprinkler protection and powerful water supplies was illustrated by a fire which destroyed the pyroxylin dope mixing and cloth coating plants of the Weymouth Art Leather Company at Weymouth, Mass., on the morning of July 11, 1939. The loss has been estimated at $450,000. Believed to have started from an explosion in a scrap pyroxylin churn or mixer, the fire quickly spread beyond the control of sprinklers due to the severe hazards and limited water supply.

The plant in which the fire occurred consisted of a conglomerate group of mostly closely built buildings of indifferent frame, frame ironclad, cement block and brick-joisted construction without effective fire cut-offs, and protected by wet pipe sprinkler systems. The plant had been moved to its present reasonably well-isolated location following a severe fire which had demolished the original plant and near-by property in 1914. Since 1918 twenty-two fires have been reported, most of which occurred at cloth coating machines and spreaders. In a previous fire in the dope making building an employee was fatally burned.

The plant consisted principally of two separate units. One of these was devoted to the preparation of dope by the dissolving of film and other cellulose nitrate or pyroxylin scrap in flammable solvents. The other was devoted to tentering and drying cloth, the spreading of the dope on the cloth, embossing, and solvent recovery.

The dope preparation building in which the fire started was a detached one- and part two-story frame metal-clad building. It was 85 by 35 feet in area, of inferior construction, with hollow walls, floors and ceilings. Scrap film and other pyroxylin material were chiefly stored in small detached metal buildings forty or more feet distant. The scrap was brought into the second floor in lots of several hundred pounds and charged into three churns in the first floor. The building also contained alcohols and other solvents in drums and tanks, and nitrocellulose in drums.

The main manufacturing plant consisted of several buildings of frame metal clad or hollow tile construction, mainly one story, adjoining and communicating without effective cut-offs and covering a ground area of about 350 by 120 feet. The cloth building was 45 feet from the dope building and pre-

International.

View of the $450,000 fire which destroyed the plant of the Weymouth Art Leather Company at Weymouth, Mass., on July 11, 1939. This plant, of combustible construction without proper fire cut-offs, handled large amounts of cellulose nitrate materials. The ordinary sprinkler equipment with which it was protected proved entirely inadequate, largely due to a very limited water supply.

sented two unprotected window openings toward it. Other portions of the main plant were also forty feet or more from the dope building. Various portions of the main plant contained considerable quantities of flammable materials used in coating operations, and one section was devoted to solvent recovery.

The electrical equipment was not of the explosion proof type as specified by the National Electrical Code for an occupancy such as this, and the general arrangements for the storage and handling of pyroxylin materials and flammable solvents indicated little regard for the N.F.P.A. regulations.

Fire Protection Facilities.

The dope preparation building had feeble sprinkler protection. Sprinklers were arranged as for an ordinary hazard occupancy and were only supplied by a three-inch pipe extended from the equipment in the main plant.

The main plant, including recent addition, was sprinklered practically throughout with a wet pipe equipment installed in accordance with the present standards for occupancies of ordinary hazard. The sprinklers were supplied only by a six-inch connection from a six-inch main fed by a ten-inch main 1000 feet distant. Normal water pressure at the ground was 35 to 40 pounds, and at the top line of sprinklers 27 to 32 pounds. Pressure in the street main was supposed to be increased by the operation of pumps on alarm of fire.

There was one public hydrant on the six-inch main in front of the plant and others within 600 feet in either direction. The public fire department consists of a paid force on a two-platoon basis, supplemented by fifteen call men assigned to each of the four fire stations. There was a fire alarm box at the plant.

In the left foreground may be seen the storage room of the Weymouth Art Leather Company which contained numerous drums of nitrocellulose material. The large ruined structure in the center of the picture was a brick-joisted cloth finishing building.

Origin of the Fire.

The plant was operating practically continuously with three shifts. As far as can be determined a workman on the morning shift entered the dope building to start the churns in which the nitrocellulose material was dissolved. Apparently a flash fire occurred, an electric spark igniting volatiles. This was followed almost immediately by an explosion of moderate intensity. The building was quickly enveloped in flames fed by pyroxylin and volatile solvents. The employee ran from the building with his clothes on fire and ran into the near-by cloth building of the main plant. Other employees there extinguished the fire in his clothing and he was taken to a hospital in a critical condition with third degree burns.

The three-inch pipe supplying the sprinklers in the dope building may have been broken by the initial explosion, but in any event the fire opened all of the sprinklers in this building and this seriously reduced the already weak water pressure on the sprinklers in the main plant. The sprinklers in the dope building were not effective in controlling the fire.

Fire Fighting Operations.

The alarm of fire was quickly given and was received at 7:10 A.M. The fire department responded promptly with two engines, a squad company and a ladder company under the command of the chief and deputy chief. A general alarm was promptly sounded, bringing two additional engine companies, an

additional ladder company and the off shift of firemen. Apparatus from other near-by departments covered vacated fire stations during the fire.

On the arrival of the first apparatus, hose was attached to the hydrant directly in front of the main plant, but no pressure was available, apparently due to the numerous sprinklers that had opened. This hydrant was then shut down. Pumpers were connected to two other hydrants within 600 feet of the plant on the six-inch main, but were unable to deliver effective streams. Other pumpers were attached to the ten-inch main 1000 feet distant and supplied good streams, but by this time all of the buildings of the plant were involved. A strong westerly wind helped to spread the fire through the plant.

Failure of the sprinkler system was due to the inadequacy of the sprinkler equipment in the dope building and the inadequacy of the six-inch public main to serve both sprinklers and hydrants simultaneously. The fire department did not shut off the water from the sprinklers until after the fire had been in progress for more than two hours.

The progress of the fire in the plant was marked by frequent explosions which occurred as the fire reached barrels and drums of dope. These explosions served to keep the firemen at some distance. In the dope building there was an empty 7000-gallon tank which formerly contained ethyl acetate. This did not explode. Another tank of 7000-gallon capacity and nearly full of alcohol went through the fire, but alcohol vapors venting from a broken pipe attached to this tank burned for hours after the fire in other portions of the plant had been extinguished.

Small metal sheds twenty or more feet from the dope building contained several tons of scrap pyroxylin. These were ignited and were wrecked by moderate explosions.

Operation of the Public Water Supply.

The public water mains are normally supplied by standpipes with pressures increased by starting electrical centrifugal pumps at the pumping station on receipt of an alarm of fire.

The recording gauge at the pumping station shows that at 7 A.M., or ten minutes before the fire, the static pressure was normal of 51 pounds. At 7:15 A.M. the pressure was 35 pounds, a drop of 16 pounds within five minutes after the first alarm. One pump was started at this time and maintained that pressure for ten minutes, when another pump was started, raising the pressure to 38 pounds. At 7:38 A.M. other pumps were put in service, increasing the pressure to 52 pounds, which was maintained for the duration of the fire. The amount of water available for the sprinklers was, however, seriously limited by the 1000 foot long six-inch street main.

Aftermath.

Soon after the fire, when the Selectmen of the Town of Weymouth met to draft a resolution of sympathy, a representative of the company is reported to

have censored the town for its failure to provide adequate public fire protection. There was no public suggestion that the owner of a highly hazardous occupancy such as this has any responsibility for providing his own protection, no mention of the fact that the other taxpayers of the community should not be expected to foot the bills for the extraordinary public fire protection that would be required to safeguard a single plant such as this without adequate private protection, and no hint that state laws or local ordinances should prevent the operating of any such hazardous processes without adequate safeguards.

McAlester, Oklahoma, Group Fire.

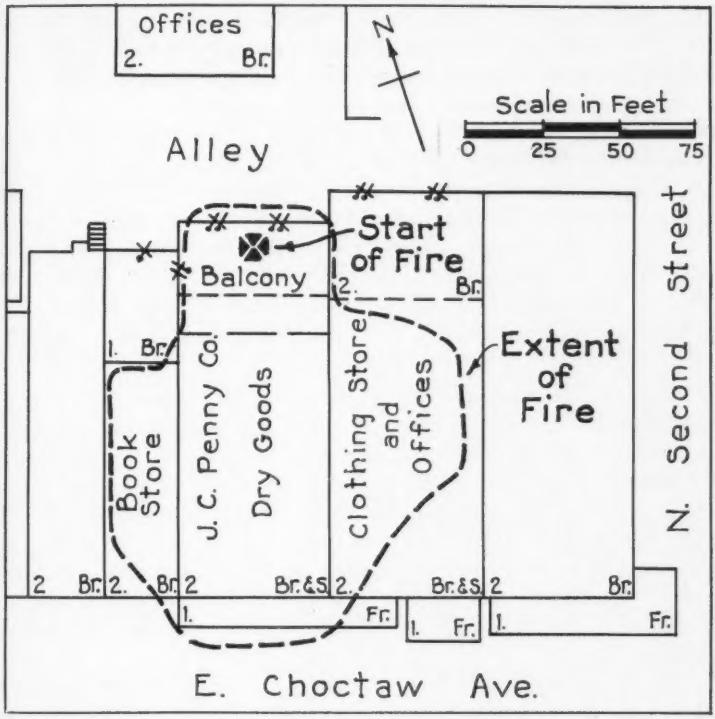
Report by Oklahoma Inspection Bureau,
(Member N.F.P.A.).

McAlester, Oklahoma, city of 15,000 inhabitants, added $7.00 to its per capita fire loss for 1939 in one night. On August 23 three downtown stores were consumed and several other buildings damaged in a fire that started from an unknown cause in a large drygoods store, one of the J. C. Penney Co. chain. Though the three stores were separated by solid walls, the fire department was unable to prevent the fire from jumping substandard parapets. Each of the three buildings was two stories in height. The two, one on each side of the J. C. Penney store, which were ignited on the roof by exposure burned down into their second floors. There the fire department stopped the spread. Practically all the damage to the first floors, and it was very considerable indeed, was done by water and smoke. Heat broke many windows in buildings near the fire area.

Story of the Fire.

The J. C. Penney store, like all the others involved in the fire, was of ordinary brick and stone construction with wooden interior. Its first and second stories were connected through an open stairway and balcony at one end. The balcony was large enough to provide considerable business space for the store. The second floor, which did not extend over the balcony, was reached by further open stairways.

Fire broke out on the balcony sometime between 5:55 P.M., when the manager and two office employees left and locked the building, and 6:20 P.M., when an office employee working in a building directly across the alley at the rear of the store noticed smoke coming from around window sills in the rear wall and through a ventilator in the roof. He noticed that all signs of smoke were above the balcony level. Through the windows, which were still intact, he soon saw a pillar of flame, also above the balcony, shoot upward in the northwest corner of the building. He then notified the fire department.



Headquarters received the alarm at 6:22 P.M. and rolled out with a pumper and a squad car with a total of five men. The fire chief was out of the city attending a fire school at Stillwater, Oklahoma, so the assistant chief was in charge.

After their arrival at the fire the firemen laid two lines direct from one hydrant. After some difficulty, they broke through the heavy locked door and barred windows at the rear and carried hose lines into the J. C. Penney building. The fire was then spreading very rapidly. A call was put in for the off duty firemen. They arrived promptly and put the rest of the equipment, already on the scene, into action. They took three hose lines through the pumper from one hydrant. These streams were played on the front of the building, to which the fire had now spread. In the meantime, firemen using the direct pressure hydrant lines in the rear had been forced to withdraw to the outside.

One man went back to the fire station two blocks distant for the combination ladder truck and hose tower, which had been left behind. Two of the hose lines from the pumper were siamesed into the tower. One of them immediately

burst. The pumper was shut down while the firemen replaced the hose. Another break delayed operations again soon after the fire tower was put back into service. These delays allowed the fire to continue completely out of control, for they involved the only really effective streams.

The fire spread to the roofs of the adjoining buildings on each side and descended into the interior through skylights previously shattered by heat. At this stage outside aid was summoned. Four pumpers responded from adjoining cities, but by the time they arrived the spread of the fire had been checked. It is doubtful that they could have been of much help anyway, for only one was equipped with adapters to fit the non-standard threads on the McAlester hydrants. This pumper was used to provide two lines. With its help the fire was finally extinguished at 11:15 P.M., about five hours after discovery.

Conclusions.

None of these buildings was provided with an automatic fire alarm or sprinkler system to detect or extinguish the fire in its incipiency. In spite of this the fire might have been confined to the building of its origin had the McAlester fire department been equipped to respond to the first alarm with a suitable supply of equipment and men. As it was, there was considerable delay in getting even the available apparatus into action, and five out of the seven lines employed before the arrival of outside aid were without benefit of pumper pressure. Though hydrant pressure was good, these streams were limited in their effect on the fire. Four out of the five were supplied from just two hydrants.

Outside aid might have been an important factor in this fire had it been called sooner and had hydrant connections been standard. Perhaps the chief, who was out of town, would have realized the inadequacy of his force of ten to control such a large fire and summoned help at an earlier stage.

The cause of the fire is unknown. The building was not equipped with heat producing devices of any kind. Neither had the last persons to leave the buildings any unusual circumstances to report.

The loss was computed at $106,200, a heavy burden for a city of this size to bear. A total of three buildings were involved, and several others suffered minor losses, such as broken glass, blistered paint, and burned roofs.

NOTE: The fire described in the above article was the second serious loss to occur at McAlester, Okla., during the past summer. On July 20, 1939, the Ethel Johnson mercantile building was destroyed with an estimated loss of $37,500.

Fires and Fire Losses Classified, 1938.

Continuing the practice begun two years ago of showing the distribution of the annual fire loss in the United States by cause and occupancy classes, the N.F.P.A. Department of Fire Record presents the following tables covering the year 1938. Experience of the past years shows that these estimates are widely used in fire prevention and fire protection work.

The data upon which these tables are based were obtained from thirteen state fire marshals' reports for 1938. Reports of these particular states were chosen because they contained the most complete classifications. While methods of reporting and tabulating fire loss figures are different in each state, it is believed that the volume of statistics from the thirteen typical states included herein is sufficiently large to indicate the relative distribution of fires and fire losses for the various occupancies and causes.

Tables I to IV are tabulations made from fire marshals' reports. Table I shows the number of fire occupancies, and Table II shows the fire loss by occupancies reported for the year 1938 in the thirteen states. Tables III and IV show the number of fires and fire losses distributed according to causes. The general classes making up both the occupancy and cause classifications were carefully chosen with regard to good practice and to classes most commonly used in the reports. Tables V to VII are recapitulations and estimates for the entire United States based upon the first four tables and adding a certain percentage to cover unreported fires and losses as explained below.

Table V is a recapitulation of the state totals presented in the foregoing tables, with columns added to show the number of fires per thousand population and the fire loss per capita. It will be observed that a total of 89,733 fires were reported in 1938 for the group of thirteen states having a total population of 34,842,000 in the 1937 U. S. census estimate. A study of the best data available indicates that this number of fires is approximately half the actual number of fires for the year, and therefore 100 per cent has been added to get the estimate for the thirteen states. When the resulting figure is applied to the whole country at the population ratio, the estimated number of fires in the United States in 1938 is 660,000. This makes 5.14 fires per thousand population as compared with 4.82 in 1937 (October, 1938, QUARTERLY, page 173).

The estimated total fire loss of $265,000,000 in the United States in 1938 was obtained by applying the population ratio to the total loss in the thirteen states and adding 25 per cent to cover unreported losses. This figure is $5,000,000 less than the corresponding figure for 1937.

NOTE: Canadian fire loss information for the year 1938 was published in the July, 1939, QUARTERLY, page 17.

Table I. Number of Fires by Occupancies in Thirteen States — 1938.

Occupancy	Illinois	Iowa	Kansas	Louisiana	Massachusetts	North Dakota	Ohio	Oregon†	South Dakota*	Vermont	Washington†	West Virginia	Wisconsin	Total
I. Public Buildings														
Government buildings	3	1	....	....	35	9	....	....	3	....	1	....	14	66
Hospitals, institutions	17	4	6*a*	12*a*	13	....	12	19	1	....	9	1	24	118
Schools	50	24	15	39	30	11	21	25	4	....	22	11	70	322
Churches	76	13	8	18	21	17	67	15	5	4	10	5	75	334
Theatres	22	11	7	14	13	4	16	20	14	4	19	6	27	177
Amusements, halls	57	28	....	....	78	3	94	....	2	2	39	....	48	351
II. Dwelling Occupancies														
Hotels, boarding houses	373	20	9	61	180	53	54	245	32	20	214	3	123	1,387
Apartments	1,861	75	....	....	....	....	1,430	....	....	....	356	12	197	3,931
Dwellings	5,728	2,587	1,711	2,242	4,632	901	11,637	3,726*d*	367	1,010	2,913	285	9,001	46,740
III. Mercantiles														
Office buildings	134	52	....	....	141	....	341	....	9	1	32	7	52	769
Restaurants, taverns	264	82	....	....	115	1	387	58	....	5	88	12	192	1,204
Barber, beauty shops	22	18	....	....	9	....	33	....	....	....	15	2	27	126
Misc. mercantiles	1,158	195	425	351	897	328	1,611	427	105	346	302	32	593	6,770
Warehouses	81	53	....	26	142	12	312	14	....	1	37	8	80	766
IV. Manufacturing														
Metal workers	29	2	15	7	10	2	....	8	....	1	20	....	28	122
Woodworkers	11	14	2	14	19	....	....	58	....	10	47	....	7	182
Flour mills, elevators	85	20	8	2	....	42	....	6	4	3	29	....	40	239
Packing plants	26	4	....	....	....	....	25	....	1	....	7	....	646	709
Bakeries	38	7	....	....	17	....	37	....	....	2	14	....	17	132
Laundries	34	5	8	....	26	2	7	....	6	....	6	....	10	104
Cleaners, tailors	42	11	....	....	8	7	8	....	....	1	13	3	13	106
Misc. manufacturing	263	38	10	180	341	11	776	127	7	9	72	14	252	2,100
V. Miscellaneous														
Barns	662	305	510	....	200	352*e*	1,499	210	68	681	116	43	580	5,226
Outbuildings	863	231	....	196	213	....	852	....	....	....	57	5	135	2,552
Lumber yards	6	7	....	8	8	3	5	....	....	....	....	2	14	53
Railroads, wharves	87	12	....	....	32	....	21	1	5	....	3	....	58	219
Bulk oil storage, refineries	62	5	29	23*b*	....	11	....	19	1	....	....	....	....	150
Garages, filling stations	1,082	241	7	15	247	36	1,584	32	46	21	90	19	373	3,793
Power, pump houses	12	7	11*c*	21	1	2	....	12	2	2	6	....	60	136
Creameries, dairies	....	4	....	....	....	12	....	....	4	1	7	....	28	56
Miscellaneous buildings	489	182	68	44	153	43	653	38	13	1	43	....	173	1,900
Automobiles	1,623	437	332	74	758	3	2,772	332	36	....	....	8	1,820	8,195
Outdoor fires	137	44	....	....	32	....	....	....	13	....	94	....	50	370
Totals	15,397	4,739	3,181	3,347	8,371	1,865	24,254	5,392	748	2,125	4,681	478	14,827	89,405

*Fiscal year ending June 30, 1938.
†Insured losses only.

a. Includes government buildings.
b. Includes filling stations.
c. Includes railroad property.
d. Includes apartments.
e. Includes all farm property.

Table II. Fire Loss by Occupancies in Thirteen States — 1938.

Occupancy	Illinois	Iowa	Kansas	Louisiana	Massachusetts	North Dakota	Ohio	Oregon†	South Dakota*	Vermont	Washington†	West Virginia	Wisconsin	Total
I. Public Buildings														
Government buildings..	$62	$700	....	....	$67,075	$2,926	....	....	$70	....	$317	....	$20,830	$91,980
Hospitals, institutions ..	13,049	326	$37,680*a*	$3,348*a*	46,438	....	$5,314	$14,220	480	....	28,608	$800	22,042	172,305
Schools	169,185	355,103	60,983	400,806	137,327	17,517	98,800	64,906	55,653	....	22,760	31,465	77,059	1,491,564
Churches	113,882	42,907	8,980	11,990	264,043	24,219	287,604	5,559	3,831	$1,838	26,793	24,050	18,892	834,588
Theatres	264,610	15,985	8,217	18,867	15,869	2,438	25,980	7,261	7,481	1,385	10,164	34,975	4,162	417,394
Amusements, halls	35,187	32,334	....	....	130,020	3,188	66,375	....	80	1,072	47,092	....	116,211	431,559
II. Dwelling														
Hotels, boarding houses	287,482	8,119	3,865	20,822	187,166	5,305	13,433	54,467	16,686	76,627	61,432	11,865	39,230	786,499
Apartments	286,499	19,929	....	....	....	....	232,992	....	....	....	91,786	18,068	40,644	689,918
Dwellings	2,570,505	1,434,226	487,438	876,827	3,569,883	212,893	2,641,813	821,518*d*	190,751	326,057	976,967	443,943	1,912,499	16,465,320
III. Mercantiles														
Office buildings	132,608	125,164	....	....	687,387	....	163,096	....	14,037	85	27,780	9,185	24,395	1,183,737
Restaurants, taverns	203,843	83,536	....	....	192,586	2,500	84,982	29,583	....	41,119	39,136	22,809	124,985	825,079
Barber, beauty shops...	4,700	9,584	....	....	12,623	....	13,273	....	....	....	3,468	2,400	4,997	51,045
Misc. mercantiles	1,025,734	696,253	543,380	499,474	1,459,645	324,532	848,806	356,599	271,183	369,855	342,753	179,329	382,965	7,300,508
Warehouses	205,412	67,427	....	65,773	705,318	9,201	542,100	123,924	....	470	147,729	16,545	170,409	2,054,308
IV. Manufacturing														
Metal workers	2,660	3,646	30,639	15,782	38,453	564	....	6,958	....	58	17,002	....	20,259	136,021
Woodworkers	28,715	9,035	21,750	407,668	42,347	....	....	338,922	....	76,661	271,167	....	8,700	1,204,965
Flour mills, elevators...	255,858	133,226	280,000	49,552	....	174,887	....	35,540	24,600	36,704	49,688	....	52,705	1,092,760
Packing plants	3,096	340	....	....	....	....	614	....	350	....	8,328	....	48,846	61,574
Bakeries	17,694	6,039	....	....	23,851	....	7,133	....	....	201	13,836	....	7,541	76,295
Laundries	37,008	278	2,163	....	54,096	12,817	87,664	....	1,436	....	2,274	....	19,537	217,273
Cleaners, tailors	15,734	6,492	....	....	16,637	2,790	10,280	....	....	200	2,620	2,243	9,121	66,117
Misc. manufacturing ...	1,194,108	173,100	22,754	1,061,306	2,200,665	2,903	1,833,593	265,751	15,263	25,903	240,624	405,685	630,694	8,072,349
V. Miscellaneous														
Barns	1,032,509	564,987	643,216	....	260,734	316,376*e*	1,390,148	255,681	43,001	689,568	95,101	68,923	986,298	6,346,542
Outbuildings	180,324	96,602	....	210,523	118,263	....	109,524	....	....	....	23,196	1,181	81,997	821,610
Lumber yards	130,000	1,840	....	129,537	2,522	32,246	199	....	....	....	....	4,100	62,419	362,863
Railroads, wharves	19,161	9,035	....	....	61,809	....	7,079	239	1,810	....	1,404	....	60,378	160,915
Bulk oil stge., refineries	721,418	5,479	11,946	123,305*b*	....	2,292	....	17,707	7,400	....	....	....	....	889,547
Garages, filling stations.	382,529	145,997	2,167	63,376	111,369	35,171	232,740	15,821	16,153	143,029	45,402	41,085	95,568	1,330,407
Power, pump houses.....	6,310	928	5,336*c*	24,115	25	1,775	....	4,886	205	8,123	7,732	....	26,787	86,722
Creameries, dairies	....	9,375	....	....	....	13,083	....	....	2,730	10,611	30,971	....	20,981	87,751
Miscellaneous buildings	227,799	74,134	131,698	50,844	639,374	58,536	1,186,040	108,180	14,753	32	101,853	100	66,183	2,659,526
Automobiles	112,272	41,205	48,227	10,291	92,138	421	87,599	26,917	4,726	....	....	3,052	138,030	564,878
Outdoor fires	35,556	6,319	....	....	150,735	....	....	....	1,874	....	42,461	....	16,255	253,200
Totals	$9,715,509	$4,179,650	$2,350,439	$4,044,206	$11,288,398	$1,258,580	$9,977,181	$2,554,639	$694,553	$1,809,598	$2,780,444	$1,321,803	$5,311,619	$57,286,619

*Fiscal year ending June 30, 1938.
†Insured losses only.

a. Includes government buildings.
b. Includes filling stations.
c. Includes railroad property.
d. Includes apartments.
e. Includes all farm property.

Table III. Number of Fires by Causes in Thirteen States — 1938.

Occupancy	Illinois	Iowa	Kansas	Louisiana	Massa-chusetts	North Dakota	Ohio	Oregon†	South Dakota*	Vermont	Wash-ington†	West Virginia	Wisconsin	Total
Chimneys, flues — defective, overheated	896	365	203	178	700	123	2,068	503	64	491	354	58	1,296	7,299
Sparks on roofs	2,066	1,194	310	220	242	28	2,973	500	....	33	232	4	762	8,564
Furnaces, heaters	1,104	159	246	146	312	193	960	489	62	175	309	17	192	4,364
Rubbish	1,193	184	12	56	....	13	939	30	31	25	....	2	100	2,585
Articles near heaters	....	13	....	....	277	....	231	....	....	....	119	10	175	825
Open lights, sparks	353	95	50	181	316	56	59	115	57	37	413	....	429	2,161
Hot ashes, coals	285	34	255	132	129	61	478	402	14	46	61	4	219	2,120
Oil burners	....	21	....	....	113	....	....	....	6	....	....	....	189	329
Smoking	2,265	351	262	662	2,185	250	2,996	1,387	43	282	864	9	2,229	13,785
Children and matches	....	76	....	....	315	....	597	....	26	....	44	....	174	1,232
Matches	....	62	....	....	311	....	825	....	11	....	72	6	362	1,649
Electrical	1,797	199	357	215	974	164	2,286	361	70	109	225	28	1,183	7,968
Appliances, motors	126	81	22	91	68	65	267	210	12	40	144	1	485	1,612
Flammable liquids, home dry cleaning, starting fires	898	140	117	209	476	130	630	71	12	135	79	7	825	3,729
Torches, welding	....	51	....	....	82	....	405	....	12	....	18	....	58	626
Films	....	5	....	....	....	....	39	....	....	....	10	2	8	64
Lamps and stoves	....	242	....	....	276	....	1,065	....	48	....	15	4	451	2,101
Gas and appliances	119	4	49	92	24	23	148	....	3	4	....	8	123	597
Grease, tar, etc.	140	24	21	59	115	44	336	268	2	37	211	....	234	1,491
Spontaneous ignition	470	163	83	29	465	70	1,003	70	30	14	96	10	251	2,754
Fireworks	27	1	6	5	71	1	24	9	1	6	8	....	25	184
Lightning	387	145	70	110	104	86	435	15	11	133	54	6	3,429	4,985
Thawing pipes	....	14	....	....	30	....	33	....	....	....	....	1	5	83
Machinery, friction, sparks	16	11	21	72	36	18	105	24	....	6	39	....	82	430
Incendiary, suspicious	151	35	12	57	326	17	287	29	4	11	81	36	35	1,081
Miscellaneous	251	342	79	29	37	49	1,693	37	11	13	202	....	256	2,999
Unknown	1,598	569	771	775	387	299	2,742	558	135	370	803	236	874	10,117
Explosions	400	....	76	26	....	51	....	67	27	21	32	....	68	768
Exposure	855	159	159	311	188	124	630	247	56	137	196	29	308	3,399
Totals	15,397	4,739	3,181	3,655	8,371‡	1,865	24,254	5,392	748	2,125	4,681	478	14,827	89,733

*Fiscal year ending June 30, 1938.
†Insurance losses only.
‡Does not include exposure losses.

Table IV. Fire Loss by Causes in Thirteen States — 1938.

Occupancy	Illinois	Iowa	Kansas	Louisiana	Massachusetts	North Dakota	Ohio	Oregon†	South Dakota*	Vermont	Washington†	West Virginia	Wisconsin	Total
Chimneys, flues—defective, overheated	$420,680	$328,723	$135,740	$102,643	$568,430	$123,823	$432,781	$172,201	$34,001	$174,009	$123,907	$90,653	$632,997	$3,340,638
Sparks on roofs	636,303	381,279	67,357	95,086	120,906	10,279	296,652	151,383	....	16,597	103,510	2,800	248,336	2,130,488
Furnaces, heaters	629,449	145,806	155,545	55,428	447,814	154,378	415,426	216,361	41,909	79,221	121,683	13,106	163,682	2,639,808
Rubbish	355,188	54,691	2,569	26,543	....	1,578	144,601	6,220	7,381	3,619	....	835	17,383	620,608
Articles near heaters	....	1,798	....	....	197,794	....	12,670	....	....	....	12,504	11,688	29,480	265,934
Open lights, sparks	115,879	42,754	19,150	68,579	291,033	12,120	80,014	17,113	44,524	1,547	128,618	....	182,854	1,004,185
Hot ashes, coals	62,370	3,873	35,056	51,059	96,348	8,069	94,808	242,104	1,801	2,381	2,041	2,703	35,796	636,409
Oil burners	....	4,943	....	....	79,016	....	....	....	424	....	....	....	21,074	105,457
Smoking	351,978	90,547	66,566	232,453	1,874,720	71,143	293,420	207,419	24,869	21,835	88,798	9,251	235,641	3,568,640
Children and matches	....	15,278	....	....	138,840	....	39,180	....	4,113	....	3,604	....	33,011	234,026
Matches	....	13,641	....	....	221,658	....	98,846	....	3,203	....	4,002	2,305	22,197	365,852
Electrical	671,871	275,018	351,121	51,277	1,077,347	131,584	1,591,499	191,184	44,895	74,844	172,063	36,148	539,287	5,208,138
Appliances, motors	12,804	51,057	7,422	31,084	42,892	2,258	25,483	7,946	1,076	1,719	14,585	566	34,865	233,757
Flammable liquids, dry cleaning, starting fires	418,930	31,774	48,062	175,023	248,446	67,372	118,036	36,909	3,584	91,246	28,298	8,474	176,634	1,452,788
Torches, welding	....	24,417	....	....	56,873	....	245,000	....	5,277	....	3,433	....	32,416	367,416
Films	....	1,180	....	....	....	....	10,208	....	....	....	1,697	7,100	2,906	23,091
Lamps and stoves	....	101,557	....	....	236,036	....	375,937	....	15,872	....	1,247	3,800	154,418	888,857
Gas and appliances	29,659	737	14,659	15,346	16,705	1,303	64,354	....	632	148	....	11,822	25,490	180,853
Grease, tar, etc.	540,300	5,814	927	9,739	88,955	3,821	79,488	18,512	65	6,948	23,539	....	26,470	804,578
Spontaneous ignition	320,251	216,710	53,617	32,144	1,213,879	58,624	911,914	65,557	131,742	24,843	173,829	22,660	506,060	3,731,830
Fireworks	2,092	7	833	333	16,397	6	2,163	108	15	9,003	2,135	....	1,429	34,521
Lightning	404,632	246,427	93,996	43,715	126,688	55,127	301,132	4,868	9,249	169,561	31,069	216,250	593,933	2,296,647
Thawing pipes	....	8,895	....	....	11,260	....	755	....	....	....	....	100	455	21,465
Machinery, friction	18,709	155,484	7,436	25,630	211,717	14,438	20,396	16,354	318	4,800	112,530	....	54,678	642,490
Incendiary, suspicious	298,347	30,044	7,873	45,355	896,161	22,966	285,064	153,406	1,095	18,817	65,813	42,758	105,171	1,972,870
Miscellaneous	117,892	160,221	11,699	88,827	137,897	12,117	524,404	21,193	4,286	12,309	58,937	....	103,998	1,253,793
Unknown	3,376,583	1,621,325	1,172,855	2,714,504	2,870,586	418,238	3,344,891	829,296	172,938	861,044	1,342,333	797,679	1,127,696	20,649,968
Explosions	491,411	....	40,670	63,345	....	29,870	....	48,840	16,873	90,051	21,762	....	48,488	851,310
Exposure	440,181	265,660	57,286	116,093	142,779	59,466	168,069	147,665	124,411	145,056	138,507	41,105	154,774	2,001,052
Totals	$9,715,509	$4,179,650	$2,350,439	$4,044,206	$11,288,398‡	$1,258,580	$9,977,181	$2,554,639	$694,553	$1,809,598	$2,780,444	$1,321,803	$5,311,619	$57,286,619

*Fiscal year ending June 30, 1938.
†Insurance losses only.
‡Does not include exposure losses.

Table VI shows the total estimated number of fires and fire losses distributed by occupancies and based on the data in the previous tables. Table VII shows similar figures by causes. These occupancy and cause classifications are not listed in any order of importance, but are grouped so that similar classes come together. Each class is broad in scope in order to reduce the number of classes to a minimum and permit the compilation of a sufficient amount of data on each to be of value. Several of the fire marshals' reports use much longer lists of occupancies and causes by subdividing the general classes shown in the accompanying tables. For example, some states divide the occupancy class "Dwellings" into "City Dwellings" and "Farm Dwellings," and the cause class "Lightning" into "Rodded" and "Unrodded."

To arrive at the estimates shown in Tables VI and VII the procedure outlined above was applied to the figures for each class in previous tables, except for those classes where data were lacking from several states. In such instances proportional increases in the total estimates were made. For example, some states did not give figures for fires in "Packing plants and smoke houses," and the total number of packing plant fires and losses was therefore increased by about one-third the total reported by the nine states. A corresponding reduction was then made in other classes; in this particular example the "Miscellaneous manufacturing" and "Miscellaneous" classes were reduced, as it is likely that the states not reporting packing plants and smokehouses used these classes for recording barn fires.

Table V. Fires per 1000 Population and Fire Loss per Capita for Thirteen States, 1938, as Reported by Fire Marshals.

State	Population (1937 Census estimate)	Number Fires	Fires per 1000 Population	Fire Loss	Fire Loss per Capita
Illinois	7,878,000	15,397	1.96	$9,715,509	$1.23
Iowa	2,552,000	4,739	1.86	4,179,650	1.64
Kansas	1,864,000	3,181	1.71	2,350,439	1.26
Louisiana	2,132,000	3,655	1.71	4,044,206	1.90
Massachusetts	4,426,000	8,371	1.89	11,288,398	2.56
North Dakota	706,000	1,865	2.64	1,258,580	1.78
Ohio	6,733,000	24,254	3.50	9,977,181	1.48
Oregon	1,027,000	5,392	5.25	2,554,639	2.48
South Dakota	692,000	748	1.08	694,553	1.00
Vermont	383,000	2,125	5.55	1,809,598	4.69
Washington	1,658,000	4,681	2.82	2,780,444	1.68
West Virginia	1,865,000	478	2.56	1,321,803*	.71
Wisconsin	2,926,000	14,827	5.08	5,311,619	1.81
Total	34,842,000	89,733	2.57	$57,286,619	$1.64
Estimated U. S. Total	129,257,000	660,000	5.14	$265,000,000	$2.05

*Estimated to be about 60% of the actual state fire loss.

Table VI. Estimated Distribution of U. S. Fire Losses by Occupancies, 1938.

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states they should not be taken as exact records for each class.

Occupancy	No. of Fires	Loss
I. Public Buildings		
Government buildings	500	$430,000
Hospitals, institutions	900	800,000
Schools	2,400	6,900,000
Churches	2,500	3,860,000
Theatres	1,300	1,930,000
Amusements, halls	2,600	2,000,000
II. Dwelling Occupancies		
Hotels, boarding houses	10,200	2,250,000
Apartments, rooming houses	43,000	4,800,000
Dwellings	336,000	75,000,000
III. Mercantiles		
Office buildings	5,700	5,490,000
Restaurants, taverns	8,800	3,820,000
Barber, beauty shops	900	230,000
Miscellaneous mercantiles	50,100	33,800,000
Warehouses	5,600	9,510,000
IV. Manufacturing		
Metal workers	900	630,000
Woodworkers	1,300	5,590,000
Flour mills, elevators	1,700	5,060,000
Packing plants	7,000	370,000
Bakeries	1,300	480,000
Laundries	800	1,010,000
Cleaners, tailors	800	300,000
Miscellaneous manufacturing	12,900	37,190,000
V. Miscellaneous		
Barns	38,700	29,400,000
Outbuildings	18,900	3,800,000
Lumber yards	600	2,260,000
Railroad, wharf property	1,600	750,000
Bulk oil storage, refineries	1,100	4,120,000
Garages, filling stations	20,600	6,160,000
Power plants, pump houses	1,000	400,000
Creameries and dairies	600	610,000
Miscellaneous buildings	13,600	12,250,000
Automobiles	60,600	2,620,000
Outdoor fires	5,500	1,170,000
Totals	660,000	$265,000,000

Note: As explained in the text, 100 per cent has been added in estimating the number of fires, and 25 per cent has been added to the losses to cover unreported losses.

Taking another example, seven states did not report the number of fires or amount of the fire loss due to the cause "Matches." Accordingly the totals reported by the other six states were doubled, and corresponding reductions were apportioned among the class "Smoking," under which it is assumed that the seven states probably recorded fires caused by matches.

As previously emphasized, these fire experience figures are approximate estimates, but give a fair indication of the distribution of losses by occupancy and by cause classifications.

Table VII. Estimated Distribution of U. S. Fire Losses by Causes — 1938.

These estimated figures are intended to show the relative order of magnitude of fire losses by causes, and while they are reasonable approximations based on the experience in typical states they should not be taken as exact records for each class.

Cause	No. of Fires	Loss
Chimneys, flues—defective or overheated	54,000	$15,400,000
Sparks on roofs	63,000	9,800,000
Defective or overheated heaters	27,000	9,900,000
Rubbish	19,000	2,900,000
Combustibles near heaters	12,000	2,460,000
Open lights, flames, sparks	9,000	1,800,000
Hot ashes, coals	15,700	2,900,000
Oil burners	7,000	1,450,000
Smoking	90,000	14,800,000
Children and matches	16,000	2,160,000
Matches	18,000	2,700,000
Electrical	47,500	23,100,000
Electrical appliances, motors	23,000	2,100,000
Flammable liquids, misc., including home dry cleaning and starting fire	27,600	6,700,000
Torches, welding	7,900	2,550,000
Films	1,000	150,000
Lamps and stoves	22,000	6,100,000
Gas and appliances	4,000	800,000
Grease, tar, etc.	11,000	3,700,000
Spontaneous ignition	20,000	17,100,000
Fireworks	1,400	160,000
Lightning	36,900	10,600,000
Thawing pipes	1,000	200,000
Sparks from machinery, friction	3,000	2,970,000
Incendiary, suspicious	8,000	9,100,000
Miscellaneous	10,000	5,600,000
Unknown	74,000	95,000,000
Explosions	8,000	3,900,000
Exposure	25,000	9,700,000
Totals	660,000	$265,000,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires, and 25 per cent has been added to the losses to cover unreported losses.

1000 School Fires.

The public responsibility for safeguarding school children from fire is generally recognized; the fire record shows to what limited extent this responsibility has been met.

The modern trend in school building construction represents a distinct improvement in construction and exit arrangements over that prevailing a generation ago. Many of the more recently built school buildings are of first-class fire-resistive construction with ample exits. But there are still a large number of schools being built in which fire safety has not received sufficient consideration; where the exterior walls are of substantial construction, giving the semblance of fire safety, but where the interior is "built to burn."

Likewise in some cities much has been done to improve the safety of the older buildings. Some of the more dangerous structures have been abandoned altogether for school purposes, others have been provided with automatic sprinklers and additional exits, and other fire safety measures have been taken. But school fires continue at the rate of seven a day in the United States and Canada, according to the statistics of the N.F.P.A. Department of Fire Record.

The National Fire Protection Association has constantly emphasized the importance of school fire safety and has consistently advocated fire-resistive school buildings with proper exits, special fire protection for existing buildings, particular care in fire prevention and the various other measures applying. A code for the proper construction and exit arrangement of school buildings has been developed by the Association through its Committee on Safety to Life, numerous educational pamphlets on this subject have been published, and the QUARTERLY has regularly printed reports on important school fires.

Ample information is available in the publications of the National Fire Protection Association as to the proper construction and protection of school buildings. Anyone who wishes to construct a fire-safe school or to remodel an existing school building in the interest of fire safety can readily obtain information as to the best methods to follow. Unfortunately there still are many who have no conception of the seriousness of the fire problem and who must be shown detailed evidence before they can be persuaded to act to safeguard the children of their communities. This detailed evidence, the fire record, is

This record is designed to replace the pamphlet "School Fires," originally published in the October, 1927, issue of the N.F.P.A. QUARTERLY magazine, and revised in June, 1931. The tables included in this present record are based on 1000 school fires reported to the N.F.P.A. Department of Fire Record between January 1, 1928, and September 1, 1939. Outstanding school fires in the United States and Canada which occurred prior to January, 1928, are covered in the text but are not included in the statistical tables.

A monument to tragic indifference to fire safety. Forty-one boys and five priests were trapped in a top floor dormitory of Sacred Heart College, St. Hyacinthe, Quebec, when a coal gas explosion started a fire at 2 a.m. on January 18, 1938. The building was of wooden interior construction, was without automatic sprinkler or automatic alarm system, and had inadequate exits.

familiar to all those who have made a particular study of this problem. The records of school fires assembled on the following pages are not intended as a complete record of thousands of school fires which occur annually, but as a compilation of typical fire experience in form available for convenient reference.

The material on the general subject of fires in schools has been subdivided into a number of separate sections: school fire disasters where major losses of life have occurred; a tabulation and statistical analysis of loss of life in school fires; detailed records of other typical fires where loss of life has occurred; a comprehensive analysis of school fires, including tables of causes, classes of buildings, places of origin of fire and the like, and selected reports of typical fires illustrating points of special interest, such as the hazard of nitrocellulose motion picture film, the effectiveness of sprinklers and the value of fire drills.

Major School Disasters.

Eight school fires in which six hundred and ninety-four deaths occurred are described in detail in this section. There are included here the two major school fire disasters of the past ten years and six previous school holocausts to which reference is most frequently made. These fires have been selected for more complete treatment than can be given the other loss of life fires recorded in the following pages.

It should be noted that a lack of proper and adequate exits has been responsible for by far the greater portion of the fatalities which have occurred in the school holocausts hereinafter recorded.

Sacred Heart College, St. Hyacinthe, Que., Jan. 18, 1938.

46 Killed.

Forty-one boys and five priests lost their lives when fire destroyed the Sacred Heart College at St. Hyacinthe, a small manufacturing city about 30 miles from Montreal. The fire followed an explosion, attributed to coal gas, at about 2 A.M., and almost instantly the 37-year-old brick-joisted building was enveloped in flames. The building was valued at $500,000 and insured for $254,000.

The available information on the details of the fire and on the pertinent features of construction and arrangement of the building is meagre. The circumstances of the fire would indicate that the building was entirely of wooden interior construction with open stairs, no interior cut-offs and no firestopping, that heating was by an old hot air system not installed with modern safeguards, and that such fire escapes as were installed were wholly inadequate as to location and arrangement. There is, however, no positive information available on these features. Unfortunately, the information received was limited to the incomplete data summarized in the following account.

It is definitely reported that the building was four stories high, although photographs indicate that one section was only two stories in height, and that at least a part of what was reported as the fourth floor was a finished attic space with dormer windows. The third and fourth floors were dormitories, where 96 boys of ages between 11 and 18 years and a few priests were sleeping. On the ground floor were sleeping 26 priests and 5 employees. Outside iron fire escapes were provided on two sides of the building. Also provided were standpipes and hose, a manual fire alarm system, and two dozen portable fire extinguishers. The condition of this equipment at the time of the fire is not known, but apparently none of it was a factor in the fire. The St. Hyacinthe fire department consisted of 11 regular firemen and 12 volunteers. Policemen also respond to alarms and assist in fire fighting operations.

The watchman, an old man with one arm, said he failed to discover anything unusual when he made his 1 A.M. round. The occupants, awakened by an explosion about 2 A.M., were confronted by stifling smoke and flames coming from the ventilators into the dormitories. Almost instantly the exits were cut off by flames, and the outside iron fire escapes were cut off by flames coming from the windows. A few of the occupants escaped by crawling through the smoke to a metal chute fire escape. (No data as to exact type or location.) Others rolled themselves in their bedclothing and jumped from upper windows into snowdrifts. None of the occupants had opportunity to dress, and those who did escape suffered severely from the 8 below zero temperature before they could find shelter.

The top floor dormitory housed 43 of the smaller boys. Priests directed these boys down an outside fire escape to the roof of another section of the building. From this point the boys were urged to jump into the snowdrifts below, but most of them, too frightened to jump, remained on the roof until it collapsed a short time later. Most of the persons on the ground floor escaped.

The first alarm was telephoned to the fire department by a passer-by at 2:03 A.M., and fire apparatus arrived within three minutes. By this time the building was already enveloped in flames and the department devoted its efforts to raising ladders to the windows. Several boys and priests had jumped to the ground. Priests assisted in rescue work, which was necessarily limited by the men and ladders available. A great many ladders would have been needed to do all the required rescue work. A lack of life nets is probably responsible for the loss of most of the boys trapped at windows and on the roof.

Attempts of firemen to enter the building were blocked by bolted doors, as the building was customarily locked early each evening. So complete was the destruction of life and property that only eight of the 46 victims could be identified when removed from the ruins.

The cause of the fire has not officially been determined, but a coal gas explosion is thought to have been responsible. The heating and electrical

equipments were inspected a few months before the fire and pronounced safe. Electric lights were burning when the fire was discovered, so electricity is not regarded as a probable cause. However, at the time of the disaster the five furnaces in the building were being pushed because of the extreme cold. Records compiled by the Dominion Fire Prevention Association show that almost three-fourths of all school fires in Canada during the previous 16 years were due to heating equipment.

Regardless of the immediate cause of this fire, no expert judgment should be required to label as a firetrap a building of combustible interior construction which housed 100 persons on upper floors without automatic sprinklers, automatic fire alarm or adequate exit facilities. A coroner's jury, after a 13-day inquiry into the disaster, attached criminal responsibility for the fire to no one, but recommended that dormitories in other old colleges and schools be placed on the lower floors instead of on the top floors, and that rigid inspection of such buildings be made to remove fire hazards. The jury also recommended installation in non-fire-resistive buildings of an automatic fire alarm system with connections to fire headquarters.

As an aftermath of this tragedy there was a temporary wave of interest in improving the fire protection facilities of all schools in Canada. The attorney general of Ontario ordered the provincial fire marshal to inspect all private residential schools in that province, and while this work was being done the fire marshal sent out to all the principals of these schools a circular, drawing to their attention the hazards from fire and the necessity of having their buildings properly constructed, with particular attention to exits, fire escapes, and sufficient and prompt means of giving alarms.

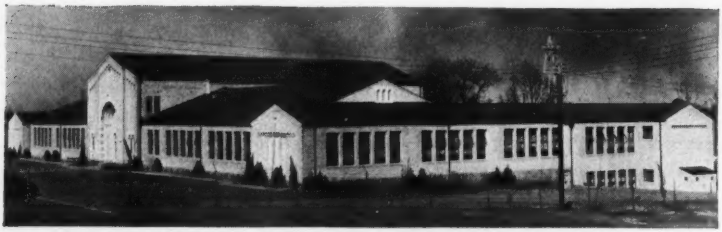
The late J. Grove Smith, Dominion Fire Commissioner, issued a bulletin pointing out that, out of 4200 school fires in Canada from 1922 to 1938, the eight largest disasters alone accounted for 342 fatalities, and that 90 per cent of the loss of life in all institutional building fires has resulted from flammable structural conditions.

School, New London, Texas, March 18, 1937.

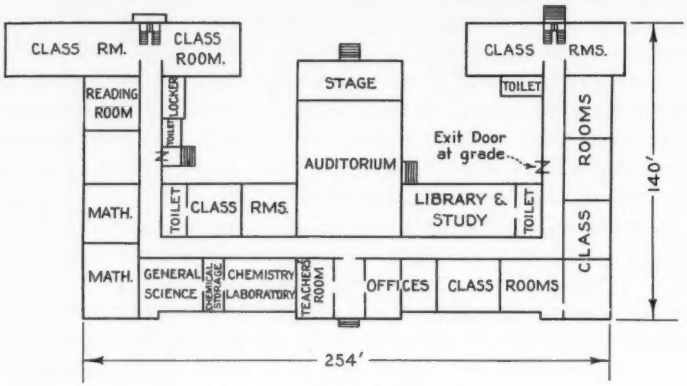
294 Killed.

The greatest school disaster of the present century took place when a gas explosion destroyed the Consolidated High School at New London, Texas, with the loss of 294 lives. Located in the heart of the oil fields, the school served the families of the oil field workers over an area extending up to fifteen miles in several directions.

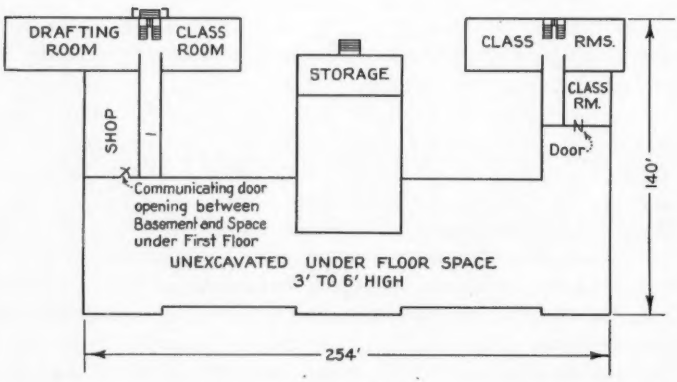
The blast occurred with the suddenness characteristic of such explosions, although with some unusual features. Witnesses agreed that there was but one explosion and that it was a low rumbling noise, with none of the blast or roar



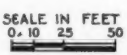
The New London, Texas, Consolidated High School before the explosion.



FIRST FLOOR PLAN



BASEMENT PLAN



that might be expected. There is evidence of a most terrific force in the great extent of devastation and loss of life that came almost instantly. Bodies were tossed 75 feet into the air, and an automobile 200 feet distant was crushed like an eggshell under a two-ton slab of concrete that had been hurled from the building. As a further evidence of the terrific force, the established point of origin indicates that the explosion had to break through an 8-in. concrete floor slab before starting on its path of destruction. Many of the children in rooms directly above this point were literally blown apart or mangled beyond recognition. There was very little of the structure left standing after the blast.

The high school was erected in 1932, with additions in 1934. Built on sloping ground, the entire building was designed in form of the letter "E." The main section was one story high on a concrete foundation forming a concealed dead air space from 3 to 6 feet high, varying with the uneven surfaces of the ground. Both the north and south wings were carried back to a height of two stories, owing to the drop in grade, the second floor in each case being a continuation of the first floor of the main section. The building was of reasonably good construction, with 4-in. brick walls backed with 8-in. non-bearing hollow tile, the loads being carried on steel I-beam columns and girders. The floor over the concealed space was an 8-in. slab of reinforced concrete supported on concrete girders, foundation walls and concrete piers. Heating was supplied by means of individual gas-fired steam radiators located in the various rooms. This method was used because of the greater expense of a central steam heating system.

A manual training shop was located on the lower floor of the north wing, containing several machines driven by individual motors, and one portable sander with a heavy cord and plug switch for a wall socket. This shop backed up against the 12-in. concrete foundation wall of the front or main section and communicated with the concealed space through a 4 x 4 ft. opening in the foundation wall, having a wooden door normally kept partly open. The shop and sander, according to evidence, played a very important part in the disaster.

It has been established beyond reasonable doubt that the explosion was due to leaking gas from a pipe or pipes under the building, and that ignition was from the arc of an electric switch in the manual training room close to the open door. No fire followed the explosion, presumably due to the small amount of combustible material.

There is no record of the total number of persons in the building at the time of the explosion, but it appears that the majority of the occupants were killed or injured, and that practically all those in the main part of the building were killed at once or were fatally injured. The final count showed that the deaths totaled 294, including 120 boys, 156 girls, 4 men teachers, 12 women teachers, 1 woman visitor and a 4-year-old boy visitor.

International.

In 17 hours following the New London, Texas, school explosion, some 2000 tons of débris were picked up and hauled away. This picture shows oil field workers engaged in removing wreckage to uncover the bodies of the 294 victims.

Those who survived were in the wings, mostly on the upper floor. There were three boys in the shop when the explosion occurred who escaped with slight injuries. They were at the far end of the room and were blown into the rear addition.

There were many reports of persons who survived by reason of the protection of desks, but it appears doubtful that there was enough time for any teacher to direct an entire class to get under their desks. The survivors who were immediately able to get out were assisted from under the wreckage in conditions varying from slight shock to broken limbs or fatal injuries. Many were pinned under the wreckage for long periods and were released only when heavy material was lifted by the use of jacks.

The court of inquiry exonerated all school officials of personal blame. It was the collective faults of average individuals, ignorant or indifferent to the need of precautionary measures, where they cannot, in their lack of knowledge, visualize a danger or hazard.

The school building was of good construction and planned for reasonable safety except for the gas piping which had been installed by one of the janitors with no apparent regard for the N.F.P.A. Good Practice Requirements, which give detailed provisions for installation and tests to avoid the danger of leaks. Furthermore, the gas was not odorized to give warning of leaks. The excessive area of concealed space under the building was poor practice for a structure of this type and occupancy, but not necessarily a structural weakness in itself. When bottled up with virtually no ventilation, however, and filled with gas pipe lines and electrical circuits, it became a serious fault.

Practically all faults of construction and installation in this building were due to lack of supervising power such as would apply in communities having proper city ordinances. It serves to focus attention on the need for state laws on standards of construction as well as approved standards for the installation of heating systems, electrical equipment, gas and oil systems, and all features affecting the welfare of the public in schools, public buildings and all other buildings where large numbers of persons congregate.

Beauval Mission School, Sept. 19, 1927.

20 Killed.

A fire in an Indian Mission School at Beauval, Lac La Plonge, Saskatchewan, in the North Country of Canada, took a toll of twenty lives on the night of September 19, 1927. Nineteen boys, between the ages of seven and fourteen, and the nun in charge of them were burned to death. Thirty-six girls and eight nuns left the building in safety.

The building was a three-story frame structure, about 120 feet long. There were five stairways: two on the outside of the building at either end, one

Nineteen boys and a sister in charge were burned to death on September 19, 1927, in this mission school at Beauval, Lac La Plonge, Saskatchewan, in the North Country of Canada.

in the center, and one at either end inside of the building. The school was equipped with chemical extinguishers.

The sleeping quarters of the boys and the nun in charge were at the south end of the third floor. The girls and other nuns occupied the second floor and the north end of the third. At the start the fire was mostly in the center of the building. Its cause is not known. It is supposed that it started from the furnace or from a galvanized iron chimney of which one of the joints may have been loose and allowed the fire to reach the wooden walls.

The Sister Superior was awakened by a crashing noise. She saw the light reflected by the fire and rang the bell that served as a fire alarm. Due to their training there was no panic among the girls. They rolled their clothes in blankets. The older girls waked the little ones, according to their drill system, rolled their clothes for them and guided them out of the dormitories. They left the building by an outside stairway. Because of the dense smoke, the nun in charge could not be sure that all had left. Their safety was attributable only to their previous training.

Meanwhile the Sister Superior was going through the corridors on the second floor waking the other nuns. She saw the fire in the center of the building, which blocked all exit from the main stairway, and led the way out by a second floor exit to an outside stairway.

The Sister Superior ran up the outside stairway to the third floor. Breaking a window, she cried a warning to the boys' dormitory. These children, being younger than the girls, were not so well trained in fire drill. If they had been they might have left their dormitory by way of the outside stairway on

the south end simultaneously with the nuns. As it was, by the time they had collected their bearings, they found this exit completely cut off by the flames that shot up past it from the open door below.

The boys and the nun with them found themselves surrounded by flames. They blindly rushed for their accustomed exit, which led down to the second floor, in the center of the building. This was a very narrow staircase with room for only one person to pass at a time and having a door at the foot. The bodies of the boys and the nun were found in the ruins of the basement at a spot corresponding with the location of this staircase.

The time consumed thus far since the first alarm was about four minutes. One of the priests from a near-by cottage emptied several chemical extinguishers on the flames at the outside door through which he hoped the boys would escape. Within five minutes the frame structure was in flames from end to end. Attempts were made to reach the boys with ladders, but these caught fire as they were placed against the building.

Rural School, Babbs Switch, Okla., Dec. 24, 1924.

36 Killed.

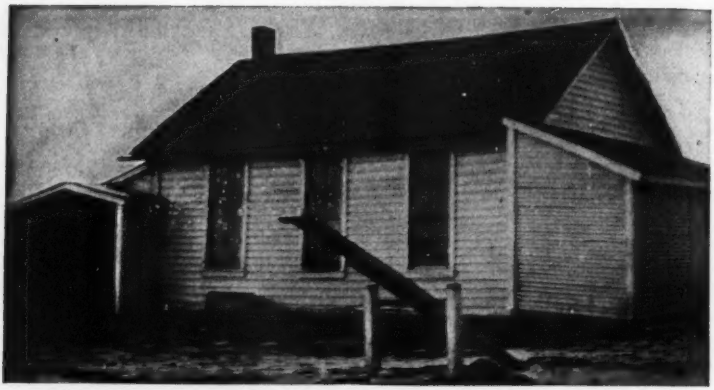
On Christmas Eve, 1924, thirty-six people lost their lives when flames swept the rural school at Babbs Switch, near Hobart, Oklahoma. Eighteen of the victims were children.

The building was a small one-story frame structure housing a single schoolroom. It had two doors, both of which opened in. One of these was entirely blocked by a built-in coal bin. The windows were heavily barred to prevent tramps getting into the building when it was unoccupied.

At the time of the fire some 150 people were crowded into the one room attending a Christmas entertainment. A Christmas tree was provided, decorated with tinsel and lighted with small wax candles. The tree was insecurely fastened to the floor, and toppled over once while being trimmed. It was again righted and fastened in the same manner.

About nine-thirty o'clock Santa Claus, in reaching for a present near the top of the tree, pulled down a branch which came in contact with a lighted candle. The branch, decorated with cotton and tinsel, was immediately ignited. At this point some persons in the audience jokingly cautioned Santa Claus to look out or he would get burned. Santa Claus then picked up a small toy chair, threw it at the burning branch and in so doing knocked over a glass bowl kerosene lamp sitting on the table near the tree, which immediately exploded.

The crowd stampeded for the door. Santa Claus, in the meantime, endeavored to smother the flame with a coat, and not being successful grasped a cotton curtain which had been used as a stage curtain. In his excitement he knocked the tree over, his clothing caught fire and in an instant he was a mass of flames. When the blaze reached the ceiling, which had been recently well



This building is exactly like the Babbs Switch school in which 36 people were burned to death on December 24, 1924. The building shown is two miles from the one which burned. The two schools were built at the same time, from the same plans. Over 150 persons were jammed into the building for the Christmas tree celebration. Men, women and children piled their bodies against the one door and were burned to death. At the extreme right is the cloakroom and entrance to the school, the door opening inward. At the left is a garage for the teacher's car.

painted with white oil paint, the fire flashed over the entire surface.

Some of those who had escaped through the narrow doorway endeavored to re-enter the building with the intention of rescuing relatives or friends, causing a complete blocking of the only exit. Outsiders endeavored to tear the window screens from their fastenings but could not do so. However, the corner of one of the screens was loosened and one small boy was rescued through this opening. About twelve minutes after the fire started the building collapsed. As is usual in such cases, the wildest excitement prevailed and no doubt many were trampled to death before being burned.

The teacher had at some previous time instructed her pupils, that in case of fire they should try to get out of the building by crawling along the floor toward the door. If any of the children tried to follow this advice, they were certainly killed.

Nearly every condition favorable to fire and loss of life was present. The building was a frame tinderbox; lighted candles were placed on a very flammable and insecurely mounted tree; kerosene glass bowl lights on tables were the only illumination; the building was crowded beyond its capacity; one doorway was blocked up by a coal bin, the other opened inward and was difficult to open, and windows were effectively barred; there was not even a fire pail, and the fire was undoubtedly spread when attacked in its incipiency by wraps and bare hands. Those who escaped from the building had to stand by and see the fire burn unhindered, there being no semblance of a water supply or fire apparatus in the vicinity.

Development School, Playa del Rey, Calif., May 31, 1924.

24 Killed.

On the evening of May 31, 1924, about 8:45 P.M., fire was discovered in the Hope Development School, at Playa del Rey, near Venice, California. As the result the matron and twenty-three of the forty-one girls at the school lost their lives. The matron gave her life attempting to save her wards. All of those rescued were led or carried to safety by the assistant matron.

This was a privately operated school for subnormal girls, although county wards were inmates at the time. One of the girls admitted that she started the fire to get away from the place. This may or may not have been true in view of her mental condition.

Previous to the fire all occupants of the building, except the assistant matron who was in her room upstairs, had retired, and the fire was discovered simultaneously by several outsiders. One of these drove to the building, gave the alarm, and attempted to rescue the inmates. Because of the rapid spread of the fire this was impossible, so he drove to the nearest fire station, about two and one-half miles away, to give the alarm. In doing this he passed five fire alarm boxes, one of which was within two blocks of the school building.

This building, built about 1900, was of frame construction, about 60 by 80 feet, two stories, with small basement which opened out on the beach. It was originally planned for a hotel, had been vacant for many years, and, about three years before the fire, it had been leased to the school. The proprietor of the school was absent at the time searching for a safe place to house the girls. Housing conditions in Southern California played their part in the tragedy. The fire chief of Venice had inspected the place from time to time, realized the danger, and while he had no authority to condemn it, had personally taken fire extinguishers into the building, placing them on the walls.

On the arrival of the first fire company the men found the entire building in flames, and by the time they had taken suction the northeast and south walls, as well as the roof, were falling in. The lives had been lost and the building destroyed before the arrival of the fire department.

Cleveland School, Camden, S. C., May 17, 1923.

77 Killed.

On the evening of May 17, 1923, fire broke out in the auditorium of the Cleveland district school while a play was being presented by the children as a part of the commencement exercises. Within twenty minutes seventy-seven people had perished in the flames.

The schoolhouse was a two-story frame building with a tin roof and ceiled with wood on the inside. The building was 100 feet long by 34 feet wide, with two classrooms and two cloakrooms on the first floor and the

auditorium on the second floor, the latter being used also as a classroom during school hours. In these rooms three teachers taught a rural grade school from first to tenth grade.

At one end of the auditorium a wooden platform eighteen inches above the floor served as a stage. Against the wall, facing the stage, was a wooden stairway from the cloakroom, opening into the auditorium at a point at the center of the building. This stairway was completely boarded up from the cloakroom to the second floor. At a point about two feet above the cloakroom floor, the stairs from the auditorium, estimated to have been not over three feet wide, ended on a landing only three feet wide. At this point a door frame intervened, thus creating an offset on each side of the stairs, which was a fatal defect in the construction. From the landing, three steps led down to the cloakroom floor. From this point, a turn to the left through the cloakroom door into the vestibule and a turn to the right led through the main outside door.

The school was lighed by metal lamps suspended from hooks in the ceiling. The first floor of the building was raised on brick piers to a distance of about two feet above the ground. The ground floor was about eleven feet high, and allowing 2½ feet for the height of window sills above the auditorium floor, it appears that the total distance from the auditorium windows to the ground was over fifteen feet.

The auditorium was filled to capacity by relatives and friends of the children from a large part of the county. The number of those present was between two and three hundred. The stage had been curtained off at each side with burlap to form dressing rooms. An oil lamp was suspended from a hook in the ceiling above the stage. During the play one of the audience observed that the wood ceiling above the lamp had ignited. He started toward the stage to extinguish the fire before anyone else should notice it and start a panic. Before he reached the stage the hook pulled out and the lamp fell to the stage. Some of the men attempted to extinguish the burning oil with a rug and with the stage curtains, which they tore from their fastenings, but the fire quickly ignited some of the curtains and flashed across the stage.

A panic quickly followed and the crowd rushed for the one small stairway. Some got through before the jam occurred at the doorway from the stairs to the cloakroom landing. This jam was largely due to parents dropping children over the auditorium rail on to the stairway below. Also many of those who escaped attempted to force their way back into the building up this same narrow stairway to save their relatives. The result was two opposite groups trying to force their way over a stairway all too small, making an unbreakable jam. The victims were so interlaced at the doorway that three men from the outside were unable to budge them and they were left in full consciousness of their fate, to perish in the advancing flames.

The result of this holocaust was seventy-seven dead, with several bodies completely consumed and others so badly burned that only two were recognizable after the fire. The greater number died from suffocation before the flames reached them, but some were conscious until the flames reached them and ended their agony. Two entire families were wiped out. There was hardly a family in the town of Camden not affected.

The potential cause of this fire was, as is so frequently the case, carelessness—an oil lamp having sufficient burner capacity to throw off through the chimney heat of considerable intensity, and this lamp suspended from a metal hook set into a wood ceiling without protection. Naturally after the wood above the lamp had been subjected to this heat for a sufficient length of time, the fibers became charred and the weight of the lamp pulled out the hook.

A single narrow exit, of a thoroughly combustible nature, for buildings of more than one story in height is too palpably wrong to even admit of comment, especially when such stairway is the exit from an auditorium where any considerable number of people congregate. In this case, the most grievous mistake was in constructing a doorway where these stairs opened on to the cloakroom landing, thus creating an offset on either side. One of the fundamental recommendations in connection with exit facilities is that stairways must be continued full width to the outside of the building.

Parochial School, Peabody, Mass., Oct. 28, 1915.

22 Killed.

On October 28, 1915, at 9 A.M., a fire was discovered in the basement of the St. John's Parochial School at Peabody, Massachusetts.

This building was 95 feet long, located about 350 feet from the street and was partly hidden by other buildings. It was erected in 1892, was three stories and basement in height, with brick walls and wooden interior, plastered walls and ceilings, partitions sheathed and varnished. There was a corridor about eleven feet wide on each floor extending the whole length of the building. On the three upper floors there were openings off each corridor into six schoolrooms.

There were two stairways opposite each other, descending to the center of the first floor corridor. These stairs, five feet wide, were the only means of exit from the upper floors. Under these stairs were entrances to the basement. The stairways on the first floor were about thirty feet apart. Between them was a sheathed partition with double doors which were kept open when the school was in session.

The school had seventeen nuns in charge of 672 pupils, of whom 300 were on the first floor, 260 on the second and 112 on the third floor. The smaller children were on the first floor.

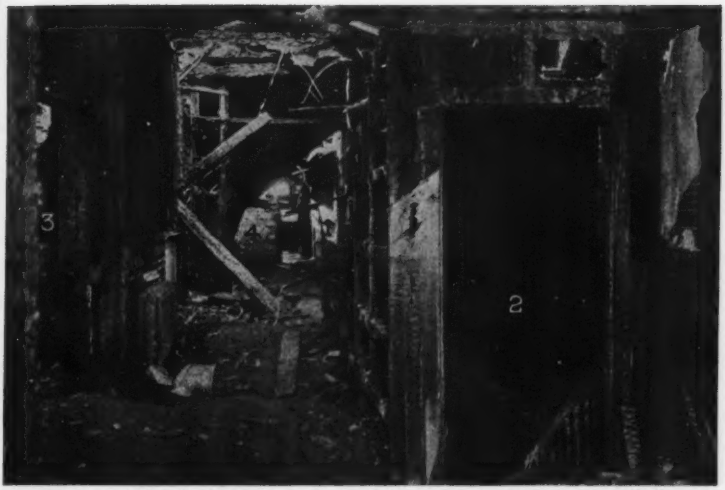
Underwood and Underwood.

St. John's Parochial School, Peabody, Mass., during the fire that took the lives of twenty-two pupils on October 28, 1915. The children had been schooled in a fire drill, but panic occurred when fire from the basement stairs blocked their exit.

On the morning of the fire the high school commenced at 8:30 o'clock and the grammar and primary grades at 8:45. The fireman who had care of the heater in the basement had been there to look after the furnace, but was absent at the time the fire started. Some of the nuns had been in the basement a half hour before the fire was discovered and at that time there were not any signs of fire. The doors to the basement were left open, as was the custom.

Five to ten minutes before the fire was discovered, the Sister Superior passed by one of the basement doors on her way to the upper floors without noticing anything unusual. When she reached the third floor, she saw a light smoke. Suspecting fire, she immediately went downstairs to investigate, and saw flames coming up over the stairs at each end of the basement. Opening a classroom door, she requested a nun to see that all exits were open, and went to the second floor to ring the bell which was the signal for a fire drill, and remained until the last child had left the upper floors.

After the bell sounded for every one to get in line and leave the building, the fire increased very rapidly. Thick smoke and flames at the ends of the corridor near the basement doors caused fright, much confusion and a congestion at the front vestibule.

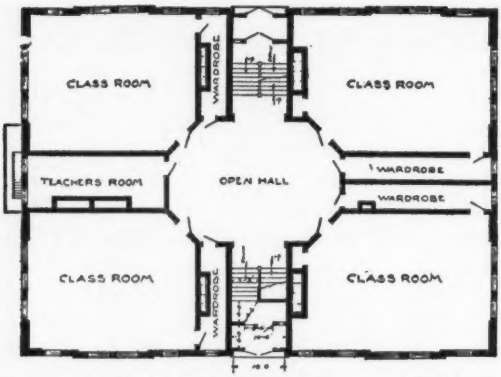


Interior of the first story corridor of the Peabody School after the fire in which twenty-two lives were lost. This photograph is taken from the point where the jam occurred. Fire started in rubbish in the basement, the flame and smoke coming up the basement stairway (2). Children coming down stairways from second story (1 and 4) and those coming through classroom doorway (3) met here and perished.

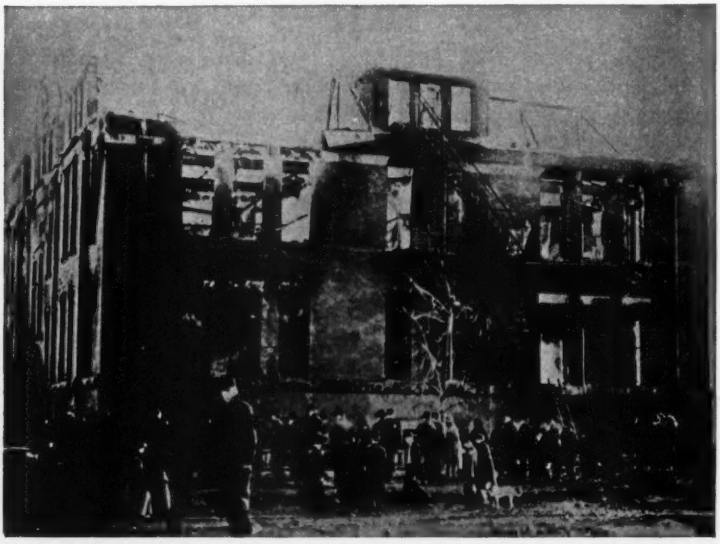
It was customary in the fire drills of the school for some of the girls and the boys to go down the back stairs out of the rear door, and the balance of the girls to go down the front stairs and out of the front door. In accordance with their training the line was well kept and the children under control until the first floor was reached.

The wind, blowing about nine miles an hour, was from the rear part of the building. As both doors from the basement and the outer doors at ench end of the first floor corridor were open, flames, heat and smoke were driven towards the front of the building.

Whether some girl accidentally fell in the front vestibule or was overcome by the heat and smoke from the basement concentrated at this point is unknown. After one child fell, others fell, until nineteen children were held in this spot by smoke and flames. When others in the corridor near the vestibule entrance saw this they turned back, and escaped either by the rear exit or jumped through windows. In the meantime, some of the nuns had reached the front entrance, and, aided by the janitor and other men who had reached the scene, rescued a number of the children who had fallen in the vestibule. This work continued until rescuers were driven away by the intense heat from the basement. This all happened before the fire department arrived at the scene of the fire. Two of the girls rescued died afterwards at the hospital.



First floor plans of the Lakeview School of Collinwood Ohio. The plan shows the open hallway and the one fire escape which saved the lives of most of the pupils on the second floor. The loss of life was caused by a jam in one of the vestibules shown.



Russell Sage Foundation.

Ruins of the Collinwood, Ohio, School after the fire in which one hundred and seventy-three pupils and two teachers were burned to death on March 4, 1908.

A telephone alarm was sent in by a fireman who happened to be off duty. He then assisted many of the children to escape through windows.

The cause of this fire is unknown. The corridor that extended through the basement had a sheathed partition on each side extending only part way to the ceiling. In this corridor there were two or three wooden barrels in which to keep the sweepings from the schoolrooms. The contents of these barrels were removed once a week. Under the rear stairs was a closet or bin some five feet wide and ten feet long.

The fire evidently started in the closet or in the rubbish barrels, as indicated by the burning at these particular points. Once the fire gained headway, with both exits from the basement to the outer air open, it spread very rapidly.

The building was a large and roomy structure, having exits thought to be ample for the number of children housed. Many times at fire drills it had been vacated in a mintue and a half. The children were well disciplined, but they had only been trained to leave the building by the way of the two usual exits. Unfortunately this line of march led directly into the corridor where the smoke and fire were pouring up from the basement. While the exits provided were all the law required, these were not adequate to provide proper safety.

Lakeview School, Collinwood, Ohio, March 4, 1908.

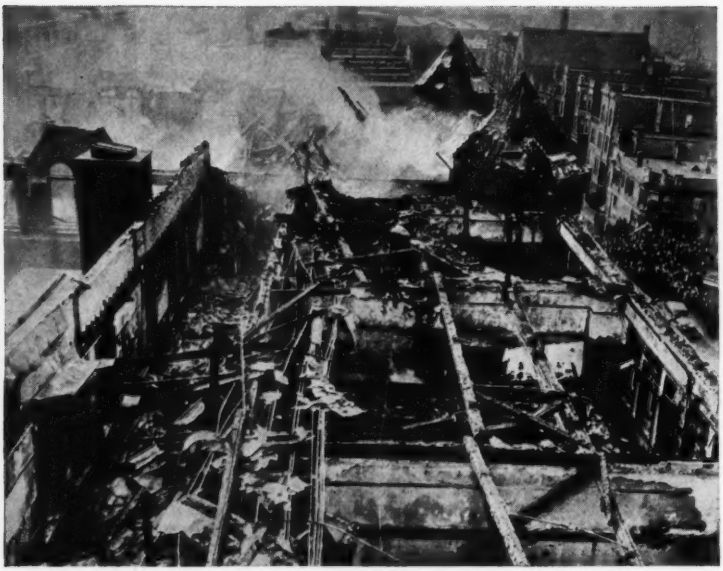
175 Killed.

The Lakeview School, Collinwood, a suburb of Cleveland, was destroyed by fire between the hours of ten and eleven o'clock on the morning of March 4, 1908, while school was in session, resulting in a loss of life of two teachers and 173 children.

Smoke was first seen coming through the crevices in the stairway at the front of the building. Flames spread with great rapidity up the stairway to the upper floors. At the discovery of the fire the janitor sounded the school fire alarm gong, and the teachers immediately gave fire drill signals. Reports indicate that the children in the rooms on the first floor were safely ushered out of the building.

In some manner, however, the children on the upper floors became panic-stricken, and made a mad rush for the rear stairway, which with the front stairway exit branched from the main corridor in the center of the building. At the bottom of the rear stairway on first floor was a frame partition, which created a vestibule between the partition and outer doors of the building.

In the mad rush the children became jammed in a heap against the inside of this partition and were found there by rescuers. So tightly were the children wedged that the rescuers could do little to free them, and consequently they perished at that location. Because all attention was directed toward saving the occupants, and due to the total inadequacy of the fire department,



Acme.

Fighting this $150,000 fire in the Tuley High School, Chicago, one fireman was killed and another seriously injured. It occurred on Sunday, February 6, 1938, when students were not in the building.

the building was totally destroyed.

At the time, the Collinwood schoolhouse was considered a modern building, of average school construction. The lighting and heating devices apparently were well installed. The building was provided with two separate exits and an outside fire escape. The children were familiar with the fire drill. All in all, there was nothing unusual in connection with the school to indicate that such a horrible catastrophe could happen. There remain hundreds of schools by no means as well constructed or secure against such a loss as was the Collinwood School.

The direct cause of the fire is not positively known, although the conclusion reached by a thorough joint investigation and inquiry made by the Deputy State Fire Marshal, local coroner, chief of Cleveland Fire Department, and members of the Collinwood Board of Education is that the fire originated from a steam main which rested on wooden joists.

Investigation also revealed that under the front stairway was a storage closet. The fact that smoke and fire were seen coming from the stairs directly over this closet, and that the closet was used for miscellaneous storage, leads to the theory that the fire may have originated there.

Loss of Life in School Fires.

In compiling the fire record of schools there were found to have been sixty fires since 1903 in which loss of life occurred. These fires include the well-known school holocausts as well as numerous fires in which only a few people were killed. It is by no means a complete list, but includes enough fires to permit generalization as to the factors causing these losses of life. A number of fires are included in which employees or firemen, rather than children, were the victims. The number of recorded deaths among those fighting school fires is far greater than in other similar occupancies, perhaps due to structural conditions or because of a zeal in fire fighting due to a special sense of responsibility for the safety of schools. The list of fires classified by occupancy, using the classification chosen in discussing the general fire record of schools in this issue, follows:

Elementary Schools.

Hochelaga School, Montreal, P. Q., February 26, 1907. Teacher and nine children trapped in building and burned to death.

Public School, Monterey, Ind., December 27, 1907. The explosion of a gasoline lamp ignited the clothing of two little girls, who were burned to death.

Lakeview School, Collinwood, Ohio, March 4, 1908. Jammed exit trapped two teachers and 173 pupils in building. All were killed.

St. John's Parochial School, Peabody, Mass., October 28, 1915. Twenty-two pupils burned to death as fire, coming up basement stairs, cut off their exit.

Negro School, Asheville, S. C., November 16, 1917. Seven children who reëntered building to save clothing burned to death.

High Point Community School, Covington, Ga., November 28, 1922. Two children were trapped on the second floor and burned to death. Thirty-eight others were more or less burned before they could escape, or injured by jumping from the second floor windows.

Cleveland School, Camden, S. C., May 17, 1923. Panic, following the fall of a lamp in an assembly room, caused a jam on the one stairway. Seventy-seven people, forty-six of whom were children, perished.

Rural School, Babbs Switch, Oklahoma, December 24, 1924. Thirty-six people (half of them children) killed in rush for the only door. The windows were covered by a heavy wire netting.

School Building, Leon, Kansas, June 7, 1927. A boy was in the attic mixing paint when fire occurred. Fire spread so rapidly that he was fatally burned before he could be rescued.

Pleasant Valley School, Troyon, Okla., March 20, 1930. Kerosene was poured into stove to quicken fire. The resultant flash filled the two-room building with flames. In spite of good exit facilities three children were unable to escape.

Bath Centralized School, Bath, Ohio, Dec. 1, 1930. One boy was killed and four others were injured when an explosion of undetermined origin occurred while they were changing their clothes in the boiler room.

School, Oteshenie, B. C., March 20, 1932. The explosion of a can of gasoline killed one girl and injured two others.

Philip School, Philip, S. D., May 5, 1933. Janitor was fatally burned when clothes were ignited by furnace.

Interior of the Deering High School, Portland, Maine, after fire of May 21, 1921. This fire, which started in a closet used by the janitor to store personal belongings, caused the loss of one life. The photograph shows the type of wooden interior construction which was responsible for the rapid spread of fire through the building.

Winterbourne School, Winterbourne, Ont., February 1, 1935. A young girl was fatally burned when an alcohol lamp exploded.

St. Gregoire Convent, St. Gregoire, P. Q., April 13, 1934. A nun was trapped and burned to death.

High Schools.

Northside High School, Minneapolis, Minn., June 18, 1913. Two firemen killed by falling walls.

High School, Wheeling, W. Va., January 3, 1914. Two firemen killed by falling walls.

Deering High School, Portland, Me., May 21, 1921. Fireman killed by falling wall.

High School, Marlboro, Mass., June 22, 1922. Girl burned to death when sparkler ignited her clothing.

Washington High School, Portland, Ore., October 25, 1922. Fireman killed by falling wall.

English High School, Lynn, Mass., March 29, 1924. Fireman killed by falling wall.

High School, University City, Mo., September 21, 1926. Workman killed when solvents of a plastic floor covering exploded. Ten others were injured.

High School, Springfield, Ill., March 15, 1932. Explosion of gas meters killed two firemen and one other person.

Sunset High School, Dallas, Texas, October 11, 1933. A janitor was killed by fire which resulted when escaping gas was ignited by a faulty electrical connection.

High School, Fitchburg, Mass., December 15, 1934. A fireman was killed when ruins collapsed.

High School, Kempville, Ont., January 8, 1936. A volunteer fireman died of a heart attack while fighting the fire.

High School, New London, Texas, March 18, 1937. A gas explosion demolished the school, with a loss of 294 lives.

High School, Wallingford, Pa., April 9, 1937. One student was killed and two others seriously injured by an explosion in the science classroom.

New Bedford Textile School, New Bedford, Mass., November 10, 1937. One boy killed and six others injured by chemical explosion in a classroom.

Tuley High School, Chicago, Ill., February 6, 1938. A fireman was killed by a falling wall.

Dormitory Buildings.

University Building, Nashville, Tenn., December 18, 1903. Fifteen girls killed in night fire.

Fraternity House, Ithaca, N. Y., December 7, 1906. Three students and three firemen killed.

Fraternity House, Ithaca, N. Y., January 31, 1908. One student killed.

Christian Brothers College, St. Louis, Mo., October 5, 1916. Nine men perished.

Settlement School, Pine Mountain, Ky., January 24, 1919. One woman and four boys killed in night fire.

Piedmont College, Demorest, Ga., January 21, 1920. A girl, who attempted to save her clothing, was burned to death.

Convent, Wilkes-Barre, Pa., March 21, 1920. One nun killed in jump from window when normal exits were cut off.

St. Boniface College, Winnipeg, Man., November 25, 1922. Nine boys and one man, sleeping in dormitory, killed.

Fraternity House, Waterville, Me., December 4, 1922. Four students died in night fire.

Hall School for Girls, Pittsfield, Mass., February 17, 1923. A servant was burned to death after losing her way in smoke filled corridors.

Normal and Industrial Institute, Utica, Miss., November 6, 1923. Two boys, while attempting salvage, trapped on an upper floor and burned to death.

St. Rose Convent, La Crosse, Wis., December 2, 1923. One nun trapped in a daytime fire and burned to death.

Hope Development School, Playa del Rey, California, May 31, 1924. Matron and 23 feeble-minded girls burned in their beds.

Mission School, Umatilla Indian Reservation, Oregon, April 21, 1926. Nun killed in jump from window.

Ely Court Boarding School for Girls, Greenwich, Conn., December 23, 1926. Employee burned to death while attempting salvage.

Beauval Catholic Mission, Prince Albert, Sask., September 19, 1927. Nineteen children and a nun were burned to death while attempting to escape.

St. Jean Berchmans Academy, Quebec, P. Q., December 16, 1927. A boy student who was ill died as a result of exposure incidental to the fire.

Nursery School, Salford, England, March 18, 1928. Five small children were burned to death in a midnight fire which destroyed a dormitory. The nearest fire brigade was 2½ miles distant and when the firemen arrived the whole upper part of the building was ablaze.

Wittenberg College, Springfield, Ohio, May 15, 1928. A girl student, overcome by smoke, was burned to death in a fire which destroyed a dormitory.

U. S. Industrial School, Dillingham, Alaska, December 22, 1928. A young Eskimo cook was fatally burned as she carried a flaming gasoline lamp out of the building in order to save the lives of 75 sleeping girls.

Oregon Normal School, Monmouth, Oregon, January 1, 1929. Three girls lost their lives when a Christmas tree caught fire in the private dormitory in which they lived. They were trapped while asleep.

Indian School, La Pas, Manitoba, February 26, 1930. Eight Indian girls and the Sister Superior lost their lives when a fire of unknown origin occurred in the sleeping quarters on the third floor. A number of others were seriously injured by jumping from windows.

St. Hyacinth's School, Hawthorne, N. Y., February 18, 1932. A nun was trapped and burned to death in her efforts to be sure that all the students had escaped.

Canterbury School, New Milford, Conn., March 18, 1936. A woman was trapped and burned to death in a fire which destroyed a combination classroom building and dormitory.

Sacred Heart College, St. Hyacinthe, Quebec, January 18, 1938. Forty-one boys and five priests lost their lives when trapped in a top floor dormitory by fire.

Other School Buildings.

Medical Building, University of Missouri, Columbia, Mo., April 10, 1920. A thief lighted a match in a room used to store alcohol and ether. He died from burns received from the flash which followed.

Gymnasium, Illinois Women's College, Jacksonville, Ill., February 22, 1929. Panic followed the ignition of a stage curtain from a photographer's flashlight powder during a celebration. One student lost her life by jumping from a window and the college matron suffered fatal burns. Fifteen others were burned or injured.

Laboratory, Holy Cross College, Worcester, Mass., November 20, 1929. A student received fatal burns when alcohol which he was using in an experiment ignited from a gas flame.

Experimental laboratory, Ohio State University, Roseville, Ohio, March 15, 1932. One man was killed and another injured when a bottle of gasoline was ignited by a stove.

Dining hall, Wesleyan College, Macon, Ga., May 6, 1933. Two negroes were killed and two others injured when gasoline fumes were ignited by an electric heater. Two gallons of gasoline in an open bucket was being used by the victims for cleaning purposes.

The tables which follow summarize the causes of the loss of life rather than the cause of the fire. Thus a fatality due to a fire originating in rubbish in a basement would, depending on the circumstances, be classed as "suffocation while asleep" or "inadequate exits" rather than as due to rubbish. Where direct fire causes are cited as causes of fatalities, this means that the loss of life was due to burns or ignition of clothing by the originating cause of the fire. The tables are thus prepared on an entirely different basis from the usual fire record tables.

The loss of life per fatal fire is high, 13.8 persons. This is swelled by the several holocausts included in this record, and by the fact that the record is not complete. This figure is slightly greater than the figure of 8.3 per fire for institutional occupancies, and much higher than the figure of 1.5 per fatal fire in dwellings, or the figure of 6 per fire in other occupancies, as shown by the previously compiled loss of life fire records.

All that remained fifteen minutes after a pupil had used kerosene to quicken the fire in a coal-burning stove in the Pleasant Valley School, Lincoln County, Oklahoma. From these ashes the bodies of three little children were removed.

Loss of Life in School Fires.

Number of fires in which lives were lost		60
	Number	**Per Cent**
Men killed	66	8.1
Women killed	67	8.3
Children killed	678	83.6
	811	100.0
No data as to age or sex	16	
Total number of lives lost		827
Loss of life per fire included in this record		13.8
Number of injuries recorded in these fires		175

The number of injuries recorded includes only those stated in the reports. In many cases no statement of injuries was made, and the actual number of injured is obviously much greater than 175. For example, no accurate report is available to show the number injured in the New London, Texas, school explosion.

The following tables are for the most part self-explanatory. In high schools one serious disaster, the New London, Texas, explosion, accounts for 294 fatalities out of 310 in this class, most of the other loss of life in high school fires being almost entirely in connection with fighting the fires. Several great disasters have occurred in elementary schools, both public and parochial. Practically all these have been due to the lack of adequate or properly arranged exits. In cases where there was more than one exit available the arrangement was often such that the fire cut off both exits. In other cases pupils went down stairs to meet fire coming up, and the press of those behind prevented retreat.

Causes of Loss of Life in School Fires.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Construction.	Number of Deaths. Public Schools	Private Schools	Colleges	Total
Fatalities which would have been prevented by superior construction. Cases where loss of life was due to failure to escape from a burning building, whatever the primary cause of fire, are classified under construction.				
Inadequate exits	252	5	52	309
Night fire, people asleep, no data as to just how deaths were caused	0	26	28	54
Exit doors opened in—barred windows	36	0	0	36
Suffocated while asleep	0	28	0	28
Fire coming up basement stairs—cut off exit	22	1	0	23
Fire coming up from 1st floor cut off second	12	1	3	16
Attempted to descend inside stairs	2	0	1	3
Trapped in attic	1	0	0	1
Total				470
Burns and Ignition of Clothing.				
Classified in accordance with the direct cause of death, including cases where the victim died of burns, irrespective of whether or not the building was ignited.				
Kerosene used to kindle fire	3	0	0	3
Lamp exploded	3	1	0	4
Clothing ignited	2	0	0	2
Total				9
Fire Fighting and Salvage.				
Fatalities resulting from remaining in buildings to fight fires which were beyond control, or from entering burning buildings in ill-advised attempts to save valuables.				
Re-entering burning building	7	4	1	12
Collapse of building or part thereof	9	0	0	9
Fire fighting, no other data	1	3	0	4
Total				25
Special Hazards.				
Ignition of flammable vapor	1	0	5	6
Ignition of plastic floor solvent	1	0	0	1
Flash fire	0	0	1	1
Explosion of gas	297	0	0	297
Explosion of chemicals	2	0	0	2
Total				307
Miscellaneous.				
Jumped from building	0	1	1	2
Died from exposure	0	1	0	1
Overcome by smoke	0	0	1	1
No data	0	11	1	12
Grand Total	651	82	94	827

In two of the major disasters, the building was being used as a place of assembly, adults and friends of pupils unfamiliar with the exits being present.

In dormitory fires most of the loss of life resulted from the fire starting at night while the occupants were asleep. In several instances the dormitories were on the top floors of large combustible buildings with inadequate exits and without proper fire alarm equipment.

Loss of Life in School Fires by Occupancy.

	Total Fires	Men	Women	Children	No Data	Total Lives Lost
High schools	15	18	12	279	1	310
Elementary schools	15	16	23	286	15	340
Dormitories	25	27	30	113	0	170
Other buildings	5	5	2	0	0	7
	60	66	67	678	16	827

Typical Loss of Life School Fires.

High Schools.

TEXTILE SCHOOL, NEW BEDFORD, MASS., NOVEMBER 10, 1937. A student was fatally injured when an explosive he was making without permission in the school laboratory exploded. Five other boys were also injured. The force of the blast caused considerable damage to the laboratory. Chemical analysis revealed that the boy was mixing sulphur and potassium chlorate in a porcelain crucible with a steel spatula. Apparently friction of the metal produced a spark which caused the explosion.

Elementary Schools.

HOCHELAGA SCHOOL, MONTREAL, P. Q., FEBRUARY 26, 1907. This was a day school. The building was two stories in height, of wood joisted interior construction. The second story was occupied as a kindergarten. The building was divided by a brick wall. There was one stairway, 4 feet wide. A wooden flue (waste paper chute) extended from the basement to the roof and opened into one of the dressing rooms. The fire occurred in the afternoon, while the school was in session, and, as reported, burned for some time in the concealed spaces between the ceiling and the floor before it was discovered. The smoke made the stairway impassable, and rescues were made by the firemen through the windows. Several ladders that were raised to the windows caught fire and could not be used. The teacher remained in the building to hand the children to the firemen and lost her life; nine of the children also lost their lives. The building was damaged but little by the fire. The waste paper chute was found badly charred, and the belief was that the fire started in it. A smoke explosion occurred shortly after the fire was discovered.

NEGRO SCHOOL, ASHEVILLE, N. C., NOVEMBER 16, 1917. Fire started in the boiler room from unknown cause while the school was in session. The janitor was absent, and the fire had made considerable headway before discovered. The pupils were all removed from the building, but a check-up later showed seven missing. These are supposed to have re-entered the building to get clothing and were caught in the flames, which spread rapidly. The building was of ordinary brick and wood construction.

Underwood and Underwood.

Nine students and one teacher lost their lives in this night fire in St. Boniface College in Manitoba on November 25, 1922. There was no fire drill. Fire escapes were inaccessible and the dead are supposed to have lost their way in the smoke-filled building.

HIGH POINT SCHOOL, COVINGTON, GA., NOVEMBER 28, 1922. Two children were burned to death and thirty injured in this fire, which destroyed the two-story frame school building. The children who lost their lives were, with forty others, trapped on the second floor of the building when their exit was cut off by the fire which started on the first floor, and many of those who escaped with their lives were seriously burned before jumping to safety. Those who were not burned received fractured legs and arms. The teacher who had charge of the pupils on the upper floor was so severely burned in directing the escape of the children, that fears were expressed for her life. When it was discovered that the fire had cut off their only means of safe exit, the teacher gathered the children about the windows and directed them in jumping to safety until all but two were out of the building. She then jumped through the flames, being seriously burned. The two children who were burned to death went down in the flames as the floor collapsed. They were boys of six and eight years. County and school authorities said that the building had been condemned more than a year previously as a fire trap.

PLEASANT VALLEY SCHOOL, TYRON, OKLA., MARCH 20, 1930. Three children lost their lives as the result of a fire and explosion which occurred when kerosene was thrown into a stove to rekindle the fire. That a repetition of the horrible disaster at Babbs Switch, Oklahoma, on Christmas Eve, 1924 (see page 155 of this record), did not occur was due to the foresight of the Board of Education in providing an additional door and arranging the hardware of doors so that they opened outward easily. Prior to alteration the Pleasant Valley School had exit facilities identical with those at Babbs Switch.

The building was of one story frame construction, supported on a concrete and stone foundation and covered with a wood shingle roof. A partition

The Christian Brothers College, St. Louis, destroyed by fire on October 5, 1916. The fire started on the fourth floor of this five-story brick joisted building and caused the death of nine men.

divided the building into two classrooms. The rooms were ceiled and finished with composition board, and the wooden floors were generously oiled. On the south side of the building was the main exit, consisting of double doors, accessible from each room through a common vestibule. There was another outside exit from each room, consisting of single doors opening outward. Three means of escape were thus available. Six windows on the north and south sides and two on each end were of ordinary glass in wooden frames, with the top sashes stationary.

On the day of the fire there were present sixty-nine pupils out of an approximate enrollment of eighty; thirty-two pupils in the primary grade and thirty-seven in the grammar grade. About three minutes before noon an eight-year-old pupil, probably feeling that the room was too cold, proceeded to give attention to the fire. This building was heated by cast iron coal stoves, located near the center of each classroom, for which purpose kerosene was customarily used in starting fires. The teacher was at the blackboard at the moment, with her back toward the class. It is thought that the pupil either poured kerosene from a five-gallon can, kept in the building for the purpose of starting fires, into a tin cup and threw the contents into the stove, or lifted the can and poured the kerosene directly into the stove. An explosion followed which set fire to the pupil's clothing. As he ran into an adjoining room his blazing clothing ignited a paper chart. A high school pupil visiting the school attempted to catch the burning pupil, but she fell and the boy was lost in the smoke and resulting confusion.

Panic immediately followed the explosion and the children rushed to the nearest exits, all of which were used in escape. Two children were assisted to the outside by the teachers after their own attempts to escape through win-

dows were unsuccessful. Both teachers in the school showed remarkable heroism in assisting the pupils to safety and spreading the alarm.

The use of kerosene for starting fires in stoves has caused the loss of so many lives and so much property that its use in schools, particularly in the hands of children, should be prohibited by those in authority.

WINTERBOURNE SCHOOL, WINTERBOURNE, ONT., FEBRUARY 1, 1935. A ten-year-old girl was fatally burned when an alcohol lamp used in a chemistry experiment exploded while she was watching the experiment. The cause of the lamp explosion was not determined.

Dormitories.

UNIVERSITY BUILDING, NASHVILLE, TENN., DECEMBER 18, 1903. This fire occurred in a four-story brick building, about 35 years old, occupied as laboratory and dormitory. Fire started at about 11 P.M., possibly from spontaneous ignition in the laboratory. It was discovered by a policeman, who sent in an alarm from a public fire alarm box. About 15 girls were killed or injured fatally. The flames had made considerable headway before they were discovered, and the firemen arrived too late to rescue the girls from the burning building, which was gutted in about an hour. There were no fire escapes.

CHRISTIAN BROTHERS COLLEGE, ST. LOUIS, MO., OCTOBER 5, 1916. The building in which this fire occurred was a six-story brick structure. The fire started on the fourth or fifth floor near the elevator shaft and spread rapidly. Delays were experienced in getting water on the fire, and, due to the high elevation, pressures were weak. Nine men were trapped on the upper floors and lost their lives.

ST. BONIFACE COLLEGE, MANITOBA, NOVEMBER 25, 1922. The burned building was owned by La Corporation du College de St. Boniface and stood in large grounds, about 22 acres, in the City of St. Boniface. It was about 290 feet long and from 60 to 90 feet wide.

It had brick walls to a height of three stories, and a mansard roof formed a fourth story. There was only a partial basement. The building had been enlarged and the old brick walls were left, but large openings were made and a corridor ran the length of the building on each floor. The stairways were open. One connecting all floors was in a brick tower, but with wood and glass doors. The interior was in part of joist construction with cast iron columns; interior finish was lath and plaster, metal and wood; there was a large amount of varnished woodwork in the trim and partitions. Heating was by steam and lighting by electricity, open wiring. There were two fire escapes of the sliding pole type with balconies on each floor.

At the time of the fire there were 154 students, all boys from 9 to 18 years of age, and 41 members of the staff sleeping in the building. Most of the students slept in dormitories on the fourth floor.

The fire was discovered about 2:15 A.M. by the Father Prefect, who was awakened by the sound of an explosion and falling glass. On going out to the corridor he saw flames in the eastern part of the building and immediately rang a hand bell; he then tried to call the fire department by telephone but could not see the numbers on the dial, it being an automatic telephone. Another member of the staff then ran to the fire station, about 1600 feet distant, though there was a public fire alarm box about 350 feet from the building.

Sixty-eight students escaped in night clothing from Mansfield Hall, women's dormitory at De Pauw University, when an early morning fire started on the top floor on October 15, 1933. Lacking ladder equipment which would reach the top floor, firemen were unable to control the fire, and $84,000 loss resulted.

Meanwhile the occupants of the building were making their escape in various ways. Most of the boys in the dormitories used the fire escapes, five were taken down ladders after the arrival of the fire department, but nine boys and one member of the staff lost their lives, and a few others were injured.

The cause of the fire is unknown. After investigation the Provincial Fire Commissioner came to the conclusion that it was caused by smoking in a lavatory. An entertainment had been given in the recreation room on the evening before the fire and some of the boys requested permission to smoke. This had been refused, but it was shown in evidence that there was some smoking.

This is only another case where the fire hazard was ignored in the construction of the building, and the result was a deplorable loss of life and property. The contents included a valuable library containing old records and documents that cannot be replaced. When the building was extended the old walls could, at small cost, have been made good fire walls dividing the building into three sections. Instead of this, large openings were cut in them. The stairways could have been enclosed sufficiently to check the spread of fire and smoke, giving the occupants a better chance to escape. The brick stair tower would have been a useful means of escape if it had been provided with fire doors, but the doors were wood with glass panels and the tower served only as a flue.

The public protection in St. Boniface was quite inadequate for a large fire. As there were no hydrants in the college grounds, long lines of hose were needed for the five or six feeble streams that were used.

No fire drills had ever been held. If the students had been drilled, there might have been less confusion and the loss of life might have been avoided.

FRATERNITY HOUSE, WATERVILLE, ME., DECEMBER 4, 1922. Four students at Colby College lost their lives in a fire which destroyed an old brick dormitory. The building burned very rapidly and, as the sleeping quarters of the boys were on the third and fourth floors, there was little opportunity for them to escape. A student coming in on a train at 3 A.M. first saw the fire and entered the building, giving the alarm on each floor and escaping by the fire escape. Many of the boys reached a fire escape which led to safety. One of the boys tried to go down the stairs, but lost his life. The other three boys that were burned to death apparently were not aroused in time to make escape possible. The exact cause of the fire was undetermined, as the structure was completely destroyed.

OREGON NORMAL SCHOOL, MONMOUTH, ORE., JANUARY 1, 1929. A flash of flame from a Christmas tree, due probably to a short circuit in wiring, set fire to a private dormitory on the campus and resulted in three girl students being burned to death. Six others escaped by jumping from a second story porch to snow banks below. The students had retired for the night and were trapped in their rooms in the upper stories of the frame building.

Fire fighting equipment on the campus was insufficient to cope with the blaze, and poor telephone service (due to a recent heavy storm) delayed calls for aid sent out to adjacent towns.

ILLINOIS WOMEN'S COLLEGE, JACKSONVILLE, ILL., FEBRUARY 22, 1929. One woman lost her life when she leaped from a second story window, another was severely burned, and fifteen others were burned or injured when a panic ensued as the result of a fire on the stage in the gymnasium during an historical pageant.

The program was almost over and a photographer was on the stage taking flash-light pictures of the girls in costume exhibiting colonial dances. He had just left the stage when the curtains, which had been closed to keep the flash-light powder smoke from the auditorium, burst into flames. A panic followed and many of the women, who were attired in the wide, full skirts of former days, were hampered in making their escape. The actual fire was confined to the curtain and scenery.

ST. HYACINTH'S SCHOOL, HAWTHORNE, N. Y., FEBRUARY 18, 1932. An aged nun lost her life when fire destroyed a three-story frame dormitory. Shortly before the building collapsed, she was last seen groping from room to room, checking to be sure all the children had escaped. Fire departments of four rural communities responded to alarms. They assisted in rescue work, but were unable to save the property because of the lack of water.

CANTERBURY SCHOOL, NEW MILFORD, CONN., MARCH 18, 1936. A woman employee was burned to death when she rushed back into a blazing dormitory building in an attempt to save her clothing. A hundred students who normally occupied the dormitory had left on spring vacation the day before the fire started. It is believed that the fire started in a closet used for storing mops and brooms. It is reported that due to the small size of the mains, the water supply was inadequate for effective fire fighting.

Statistical Record of 1000 School Fires.

The files of the Department of Fire Records of the National Fire Protection Association contain reports on many hundreds of school fires, including buildings of all classes used for educational purposes. For the purposes of this record, 1000 school fires reported to the N.F.P.A. Department of Fire Record as occurring between January 1, 1928 and August 1, 1939, have been chosen as a representative basis from which to prepare statistical studies of recent school fire experience. The record is by no means complete and does not include many of the small fires which are occurring daily in school properties. The detailed reports from insurance inspection organizations, which are the principal source of data on fires in industrial properties, are found in comparatively small number in the school fire record classification. This may be because of the large extent to which public school property is uninsured or because the money losses involved are not of sufficient interest to the insurance organizations to justify the expense of investigation and the preparation of detailed reports, except in the larger fires. Many of the reports are based on newspaper accounts which have been verified. Insurance inspection bureau reports, are, however, the source of data on a majority of the private school and college fires.

In view of the character of the original data, which include the larger and more important fires but not a fair proportion of the smaller fires, loss data in this record may not be completely representative. The record, however, includes a broad selection of the important school fires of the past decade so that there can be no question as to the validity of conclusions drawn in the tables here.

The frequency and loss from school fires are shown by estimates of the N.F.P.A. Department of Fire Record, which indicate that fires occur in school property at the rate of six or seven a day in the United States, and nearly one a day in Canada. The total school fire loss in the United States and Canada is estimated at over $6,000,000 yearly.

Nearly every kind of school is included in the N.F.P.A. fire record. The following is the number of fires in the record of each type of school:

Kind of School in Which Fires Occurred.

	No. Fires
Public elementary schools	287
Public high and junior high schools	255
Colleges, universities and normal schools	257
Private schools and convents	128
Parochial high and elementary schools	45
Business and trade schools	28
Total	1000

The burning of a country school. Fire department and available fire apparatus in foreground.

This indicates a considerable variety available for study. It is apparent, however, that certain types of schools have similar fire hazards. High and elementary public schools are usually housed in buildings used for no other purpose, where the buildings, even in the city, frequently occupy a position relatively isolated from other buildings. Parochial schools and convents are frequently in or adjacent to other church property. Business schools are often in mercantile or office buildings, as are some trade schools. Boarding schools range from the small private school where living and classrooms are all under a single roof, to the large academy type of institution which has a group of buildings comparable to a university or college property. A building used as a dormitory has the same hazard, regardless of whether it is part of a university, private boarding school, normal or trade school or convent. A building used for classrooms, laboratories, etc., is as hazardous as a part of a university as if a part of a private school.

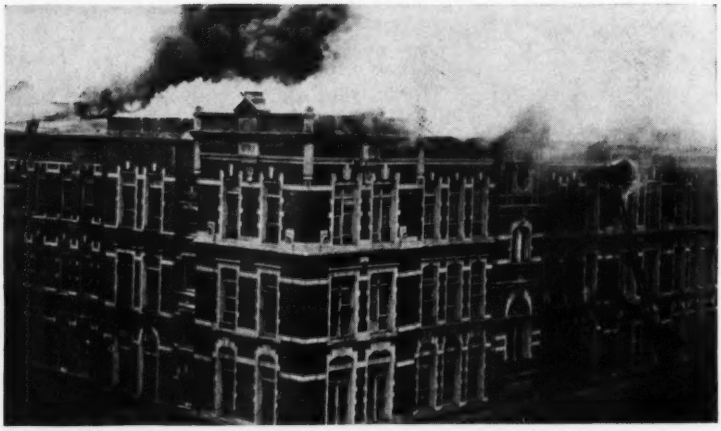
The following table shows the type of buildings involved regardless of the nature of the school in which they were employed.

The burning of Dickinson Hall, Princeton University, May 15, 1920. In this fire were destroyed irreplaceable works of art and historic collections.

High schools, including junior high schools, which are essentially the same in character as high schools, although housing younger children, are considered somewhat more hazardous than elementary schools because of their usually larger size and because of the chemical laboratories, domestic science and manual training rooms they contain. The elementary school classification contains fires in 287 schools. The elementary schools are for the most part buildings devoted entirely to classrooms and have a relatively lower potential hazard than other schools.

Types of Buildings Involved.

		No. Fires
Classroom buildings		720
Dormitories		165
Workshop and laboratory buildings		33
Gymnasiums		20
School store and office buildings		16
Service buildings		19
Chapels or auditoriums		11
Recreation buildings		8
Libraries		3
Miscellaneous buildings		5
Barn or stable	2	
Armory	1	
Garage	1	
Museum	1	
Total		1000



International.

A three-alarm fire caused serious damage to Public School 89, New York City, shortly after classes had been dismissed on March 5, 1935. This view shows firemen attacking the fire at the roof and ventilators from aerial ladders.

It was found impossible to tell from most of the reports of fires in dormitory buildings whether or not the building was solely used as students' quarters, and so in this classification "Dormitories" includes buildings used exclusively as dormitories and also numerous buildings used for classroom and laboratory purposes as well. This classification embraces dormitories attached to all kinds of schools: universities, colleges, normal schools, trade schools, private boarding schools and convents.

The classification "Workshop and Laboratory Buildings" includes buildings devoted to woodworking, metal working and other kinds of shops, as well as buildings housing laboratories primarily.

The relative frequency of school fires of all types in cities is indicated by the following table, which shows the number of fires occurring in a group of large cities over a period of ten years.

Year	New York City	Philadelphia	Boston
1928	22	12	7
1929	22	12	14
1930	53	9	7
1931	45	9	11
1932	61	10	11
1933	36	16	9
1934	42	14	9
1935	48	12	10
1936	58	8	10
1937	49	13	2
Total	439	115	90

Causes of School Fires.

The next table shows the causes of school fires in the N.F.P.A. records.

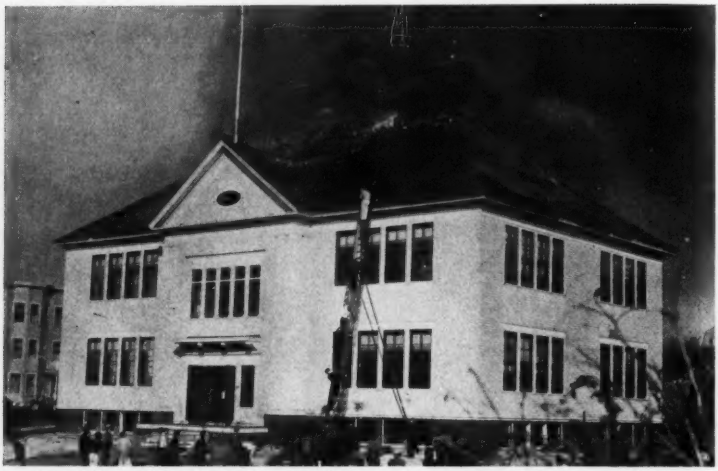
Causes of School Fires from N.F.P.A. Fire Record.

	Public Elementary Schools	Public High & Jr. High Schools	Colleges and Normal Schools	Private Schools and Convents	Parochial Schools	Business and Trade Schools	Total
Electrical causes	25	28	23	15	5	1	97
Smoking—matches	19	12	25	10	3	5	74
Incendiary	29	26	8	7	2	0	72
Defective or overheated heating equipment	26	11	14	8	7	2	68
Spontaneous ignition	14	26	14	5	2	5	66
Ignition of flammable liquid or gases	7	11	23	3	2	2	48
Defective or overheated flue or chimney	13	13	10	6	3	0	45
Sparks on wooden shingle roofs.	11	7	9	3	1	0	31
Rubbish and litter	13	5	7	2	1	1	29
Sparks from fireplace or stove	1	0	8	7	0	0	16
Chemicals	0	5	6	0	0	0	11
Lightning	2	1	2	4	0	1	10
Acetylene or gasoline torch	3	3	2	1	0	0	9
Defective oil burner	2	0	3	0	3	0	8
Motion picture film ignited	1	4	2	0	0	0	7
Electric iron left on unattended	0	0	2	3	0	1	6
Exposure to other fires	1	2	1	1	0	0	5
Steam pipes ignited woodwork	1	0	1	0	0	1	3
Miscellaneous causes*	5	4	6	1	2	0	18
Unknown causes	114	97	91	52	14	9	377
Total	287	255	257	128	45	28	1000

*The miscellaneous known causes in the table are made up of the following fires:

Defective water heater exploded	2	Boxes piled against chimney cleanout	1
Candle ignited paper decorations	1	Roofer's tar kettle overheated	1
Sparks from chimney ignited sheathing below slate roof	1	Furnace door left open	1
		Defective kitchen range	1
Sparks from chimney entered ventilating duct	1	Unattended gas burner	1
		Flashlight powder ignited curtain	1
Painter's torch	1	Explosion at oil tank	1
Janitor's clothing ignited	1	Hot ashes in combustible container	1
Truck crashed into school and ignited.	1	Charcoal heater left unattended	1
Firecracker ignited window curtain	1		18

This table of fire causes indicates that schools as a class are not particularly different from other occupancies, as the more common fire hazards head the list. Seven items are responsible for 470 out of 623, or over 75%, of the fires listed in the N.F.P.A. fire record for which the cause is known.



The Wilson School at Auburn, Me., was more than a block away from the main area destroyed by the conflagration of May 15, 1933. Sparks set fire to its wooden roof. The picture shows the roof burning furiously as a fire company attacked the fire. The fire spread rapidly over the combustible roof and destroyed the entire building.

Electrical causes lead the list of fire causes with 97 fires attributed to this cause. "Defective wiring" as a fire cause is often open to question, and it is possible that in a number of fires in this record in which this cause was assigned there may be some doubt as to whether or not it was the actual cause.

Smoking appears to be on the increase in high and elementary school buildings as compared with earlier tabulations, and causes most of the fires in dormitory and miscellaneous buildings where smoking is usually unrestricted.

It is interesting to speculate on why incendiary fires should be a leading cause in public elementary and high schools. Many of these, the reports quite definitely state, were set by children who did not want to attend school. In a few cases the fires were set to cover up thefts. Also, unfortunately, many schools are tempting marks for pyromaniacs, because of large areas, combustible interiors, wide open stairways and halls, and lack of suitable watch service.

Defective or overheated heating apparatus seems to be more frequently a cause of fire in the public schools than in the other types of buildings, whereas defective flues or chimneys are an important cause of fire in all the occupancies.

Spontaneous ignition commonly takes place in rubbish accumulations, especially when these contain oily sweepings or rags. There are more fires due to this cause in high school and laboratory buildings because chemicals which aid spontaneous ignition are sometimes swept into the rubbish.

This picture shows the Arlington, Washington, High School Building shortly after it had caught fire from the adjoining science building on July 11, 1934. Note volume of smoke from burning wooden shingle roof. Inadequate water pressure to allow sufficient streams handicapped firemen. The loss was $44,390.

The number of fires on wooden roofs from chimney sparks confirms the already existing evidence that wood shingles are unsuited to use as a roof covering. This cause stood eighth in school fires. Many of these fires were in rural schools where a lack of fire protection allowed the complete destruction of the building. City schools and schools of considerable size are ordinarily provided with fire retarding roofings.

The large number of fires as shown by the above table being attributable to smoking and spontaneous ignition, both the usual result of untidy conditions, emphasize the need of attention to good housekeeping by school administrators. So many fires, too, from defective chimneys and heating apparatus indicate that an annual inspection and repair of all heating equipment, flues and chimneys is necessary. Electrical fires may be prevented by proper inspection and by making renewals where old and faulty wiring is found.

The record also emphasizes the importance of lightning protection. The large proportion of fires of unknown cause does not indicate any mystery inherent in the origin of school fires; many of the fires here reported as of unknown cause could doubtless have been assigned to some definite cause if they had been properly investigated by an experienced fire inspector.

While not as frequent an offender as some of the other causes mentioned above, the hazard of gas explosions should not be overlooked, as this has been the cause of three serious school losses, including the New London, Texas, disaster. A more detailed report on this hazard is given on page 210.

The $250,000 fire at Herman, Pa., which destroyed St. Fidelis Catholic Seminary on March 16, 1938. Fire started in the first floor carpenter shop, and sixty-five students asleep in the third floor dormitory escaped only a few minutes before the fire cut off all exits. In addition to two buildings, a valuable library and all records of the institution were destroyed. Combustible interior construction, unprotected openings, and insufficient water were contributing factors.

Causes of Fires in Public Elementary and High Schools.

	No. Fires	Per Cent
Incendiary	55	16.6
Electrical causes	53	16.0
Spontaneous ignition	40	12.0
Defective or overheated heating equipment	38	11.4
Smoking—matches	31	9.4
Defective or overheated chimney or flue	26	7.9
Sparks on wooden shingle roofs	18	5.5
Ignition of flammable liquids or gases	18	5.5
Rubbish and litter	18	5.5
Acetylene or gasoline torch	6	1.8
Motion picture film ignited	5	1.5
Chemicals	5	1.5
Lightning	3	.9
Exposure to other fires	3	.9
Miscellaneous known causes	12	3.6
Total known causes	331	100.0
Unknown causes	211	
Total	542	

Fire of supposed incendiary origin was discovered in a first floor conference room on the first floor of historic Dartmouth Hall of Dartmouth College, Hanover, N. H., shortly after 1 A.M. on the morning of April 25, 1935. The fire spread up a clock weight tower to the roof space, where it jumped unparapeted fire walls, destroying the entire roof and tower, and caused $87,000 loss.

Construction of Buildings.

The predominating construction of the school buildings involved in the fires recorded is, as the above table shows, "ordinary construction." That is, masonry walls with wooden interior. About half of the buildings in this classification were described as of brick and wood-joist construction—the remainder were described variously as "brick" or "stone," the usual meaning of these terms being that the walls were of brick or stone but that the interior was of ordinary wooden construction. It is possible that some of these were in reality brick-veneered only. It is somewhat less likely, though of course possible, that there may be a few fire-resistive buildings included in this classification. Usually a fire in a fire-resistive building is a sufficient surprise to warrant mention of the type of construction in the report.

The number of fires in fire-resistive buildings, shown in the table, is increased by the reports of several small fires in fire-resistive technical school buildings. Comparatively few of the public schools included in this record were fire-resistive. A few were partly so; some had fire-resistive walls, corridors, etc., but otherwise constructed of wood; some had fire-resistive basements only, and a few were fire-resistive except for the roof.

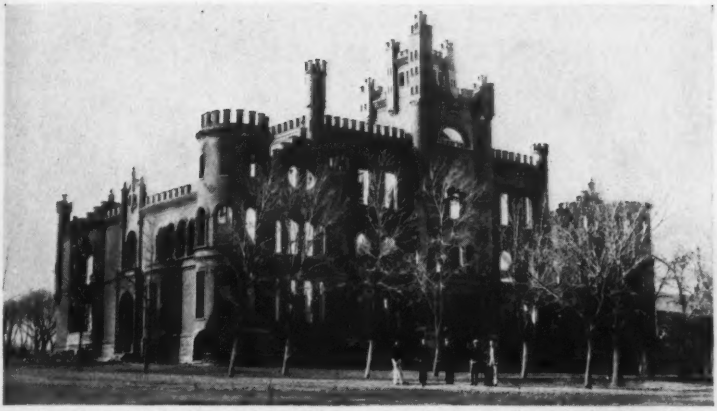
Impressive brick walls, coated with ice, were about all that remained of the Jefferson High School at Bloomington, Illinois, following an early morning fire on March 7, 1932, which caused $107,000 loss.

Roof fires are of importance in the case of public schools. This is due to the use of wooden shingle roofings, which is quite common on rural schools.

The hazards of combustible wooden interiors which frequently had well-oiled floors were in most cases greatly aggravated by the ability of the fire to spread up large open stairways, unprotected ventilating flues leading to classrooms and attic spaces, and other vertical openings. With this type of construction fires were difficult to control, because, even where the fire department arrived promptly, the blaze had frequently spread from floor to floor and was beyond control.

Construction of Buildings Involved.

	No. Fires
Brick, stone or concrete block walls with wooden interior	444
Frame	181
Fire-resistive	34
Partly fire-resistive	14
Brick or stone veneer	13
Iron clad	11
Stuccoed frame	4
No data (largely combustible construction)	299
Total	1000



Sturdy brick towers and battlements remained a hollow shell after flames destroyed the combustible interior of the administration building of the Northwestern State Teachers College at Alva, Oklahoma, on March 1, 1935, with a loss of $313,000. Lack of vertical fire stops and absence of private alarm and fire protection facilities were responsible for the large loss, which was not insured.

Discovery of Fires.

Only one of the fires in this record, aside from those in sprinklered schools, was discovered by the operation of an automatic fire alarm. In most cases where automatic sprinklers were involved, attention was drawn to the fire by the automatic sprinkler alarm. Fires in dormitories were most frequently discovered by the occupants themselves, but on many occasions discovery of the fire came too late to prevent a large property loss or loss of life.

While all of the fire reports do not state how the fire was discovered, sufficient information is available to show that about three-fifths of all fires involving classroom buildings occurred at times when buildings were not occupied. From a point of view of life safety, this fact may have prevented fatalities and injuries in firetrap schools, but it also implies that many of the fires gained considerable headway before they were observed. Most of the fires which occurred while buildings were occupied were discovered by teachers, janitors and other school employees.

Analysis of Loss.

The following analysis of the losses reported show how large a proportion of the fires in this record were severe losses. This is due partly to the fact that the N.F.P.A. Department of Fire Record does not receive reports on the many inconsequential fires in schoolhouses. The generally combustible construction, usual delay in discovery of the fire and frequent lack of fire protection are reasons why the loss is frequently large when a school building catches fire.

International.

Near-zero temperatures hampered efforts of Waltham, Mass., firemen on February 16, 1936, when fire, starting in the basement, destroyed the College of Physicians and Surgeons Building at Middlesex College.

Analysis of Loss.

	Public Elementary Schools	Public High & Jr. High Schools	Colleges and Normal Schools	Private Schools and Convents	Parochial Schools	Business and Trade Schools	Total
Less than $100	30	16	18	6	7	1	78
$100-$1000	14	7	24	8	3	4	60
$1000-$10,000	28	22	34	26	6	2	118
$10,000-$50,000	70	86	50	29	7	9	251
$50,000-$100,000	35	54	27	9	2	2	129
$100,000-$500,000	8	29	24	10	2	1	74
Over $500,000	0	2	4	2	0	0	8
Small (loss not stated)	48	22	45	19	10	4	148
Moderate (loss not stated)	19	3	6	5	1	2	36
Large (loss not stated)	19	8	16	9	4	2	58
No data	16	6	9	5	3	1	40
Total	287	255	257	128	45	28	1000

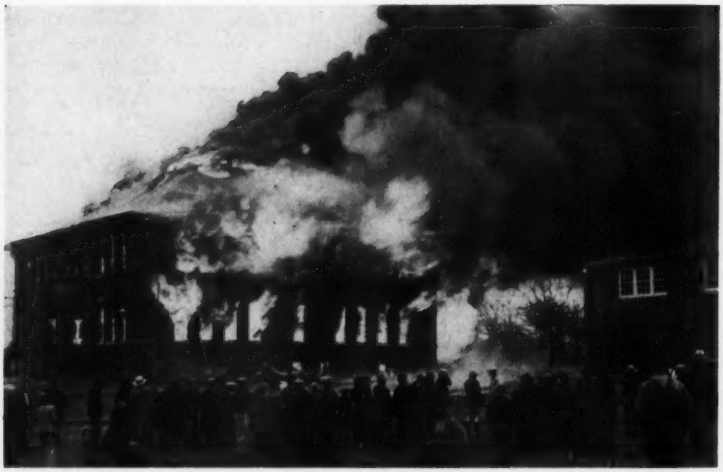
The following table shows the hazardous portions of the buildings. The basement stands out as the most frequent source of the fires. This has long been known to be the most hazardous portion of the building. Member Henry A. Fiske, using data then available, pointed out in the January, 1931, QUARTERLY, page 272, that over one-quarter of the fires in schools were in basements. He argued from that fact that even partial installations of automatic sprinklers, particularly for basements, would be helpful, especially as a life safety measure, when funds are not available to sprinkler the whole building. The danger of basement fires cutting off escape of occupants would thus be removed.

Room in Which Fire Originated.

	Public Elementary Schools	Public High & Jr. High Schools	Colleges and Normal Schools	Private Schools and Convents	Parochial Schools	Business and Trade Schools	Total
Classroom	62	26	15	9	3	6	121
Furnace room	38	18	21	13	11	3	104
Basement other than furnace room	32	32	18	10	11	1	104
Dormitory room	0	0	44	14	0	1	59
Roof	22	13	9	7	1	1	53
Auditorium or chapel	6	23	11	4	2	0	46
Chemical or biological laboratory	2	17	21	1	1	1	43
Attic or roof space	13	10	9	3	2	1	38
Closet	10	8	7	5	0	0	30
Hallway or corridor	5	7	5	7	1	2	27
Storeroom	5	5	5	3	1	2	21
Gymnasium	0	5	11	4	0	0	20
Outside of building	10	3	3	1	1	0	18
Office	5	1	6	4	0	0	16
Manual training room	1	11	2	0	0	2	16
Locker room or toilet	5	2	4	1	0	3	15
Mechanical laboratory or shop	1	3	8	0	0	2	14
Kitchen or restaurant	0	3	6	4	0	1	14
Social room	1	1	6	6	0	0	14
Waste paper room or chute	1	3	6	2	0	0	12
In wall or partition	5	1	0	2	0	0	8
Library	1	2	3	0	0	1	7
Domestic science room	1	4	1	0	0	0	6
Motion picture booth	1	3	2	0	0	0	6
Belfry or cupola	1	1	1	2	0	0	5
Power room	1	0	2	1	0	0	4
Garage or barn	0	0	3	1	0	0	4
Coal bin	0	1	1	1	0	0	3
Miscellaneous known locations	0	3	2	0	0	0	5
No data	58	49	25	23	11	1	167
Total	287	255	257	128	45	28	1000

The above table shows that classroom fires are a serious problem in elementary schools. Much of this is unfortunately due to vandalism directed against unpopular teachers.

The basement of an elementary school is a relatively greater hazard than the basement of a high school. This is probably due to the fact that high school basements are usually finished, and house classrooms, lunch rooms, locker rooms, gymnasium, etc., and are accordingly kept cleaned up, whereas the average elementary school basement is unfinished and frequently its otherwise unoccupied spaces become catch-alls for old furniture and rubbish. The heating plants of elementary schools are often not so well installed as in the larger high school buildings.



The fire which destroyed the Harrah, Okla., primary school building started while approximately four hundred children were in the building. The blaze started in hot air registers and little attention was paid to first signs of smoke, as rubbish smoldering in the ducts was a usual occurrence. The fire spread rapidly to all parts of the building, but all children escaped due to well-conducted fire drills and use of escape facilities.

Fire Exit Drills.

It would be interesting in the case of fatal school fires to know just how much a factor a fire drill might have been in getting people out of the building, or how frequently lack of it was a direct cause of fatalities. The reports in this record, however, do not show these facts except in a few cases. The following typical fires show the importance of properly organized and conducted fire drills in enabling the safe escape of large numbers of children when fire occurs.

School Fires Showing the Value of Drills.

HIGH SCHOOL, NEW YORK, N. Y., OCT. 22, 1928. Four minutes after the sounding of the school's fire alarm 1800 students of the Morris High School, between the ages of twelve and eighteen, were on the sidewalks in front of the building, cheering the firemen as they stretched their hose to extinguish a fire on the fifth floor.

The fire was discovered by a student in a storeroom adjoining a classroom. He sounded the school fire signal and the pupils marched out in drill formation by way of the stairs. Sixty crippled children were removed by way of the elevators.

PAROCHIAL SCHOOL, BROOKLYN, N. Y., JAN. 8, 1929. Prompt action on the part of teachers averted what might have been a disaster, when a fire, due to a defective flue, was discovered in an old wooden school building housing 213 pupils ranging in age from six to fifteen. There were no signs of panic, in

P. & A. Photo.

Six hundred children had just left this building for their noon recess when fire of undetermined origin broke out. The Victoria School, Winnipeg, Manitoba, March 20, 1930.

spite of smoke which filled the lower floor, and the building was cleared in three minutes. Five minutes later the ground floor was in flames, which spread rapidly and resulted in the virtual destruction of the structure with a loss estimated at $75,000.

ELEMENTARY SCHOOL, HUDSON, N. H., JAN. 14, 1929. Half an hour before the close of school 300 children, ranging from six to fourteen years of age, at the Webster School, marched out to safety when a fire originating in the basement rapidly filled the building with smoke and destroyed the two upper floors.

The teacher who discovered the fire quietly dismissed her own class, telling them it was too cold for them to remain longer. She then notified other teachers and the fire gong was sounded. The pupils lined up as they had been instructed to do in fire drills and marched quickly out, leaving their overshoes and other belongings inside.

Hardly had the last child reached outside when the structure burst into flames. The fire was due to overfiring the heater. Five classrooms and the roof were damaged with a loss of $11,625.

PAROCHIAL SCHOOL, ARCTIC, R. I., OCT. 14, 1929. Through clouds of smoke that filled the building after a fire started around an oil burner in the basement, 250 children were led to safety by the Sisters of St. John's Parochial School.

A state law requires that a fire alarm box be provided on every school building, and as a result of the prompt sounding of the alarm from this box the fire department was quickly on the scene and ready to fight the fire before the last of the youngsters had left the building.

A $40,000 loss occurred at this Ukranian Catholic Seminary at Stamford, Conn., on May 22, 1938, when a fire, started on the outside by a painter's torch, spread into the large combustible roof area and seriously damaged the building.

ELEMENTARY SCHOOL, FORT WORTH, TEX., MARCH 28, 1930. When fire was discovered in the basement 475 pupils of a grade school marched or slid down fire escapes to safety. Within a few seconds the blaze had spread up a stairway and along the hall. Stairways to the second floor were blocked by flame and smoke. Regular fire drills saved the children, who marched to fire escapes in orderly fashion and quickly vacated the building.

HIGH SCHOOL, HARRAH, OKLA., MARCH 6, 1931. A considerable drop in temperature caused the school janitor to build a very hot fire. The children went into the building as usual at 9:00 A.M. Soon after, smoke was noticed, but at first caused little concern, as papers sometimes got into registers and burned. Presently, however, a teacher on the first floor noticed flames in the duct below the register. She immediately dismissed her room and sounded an alarm.

The building rapidly filled with smoke, rising up the stairways to the second floor. The children on the first floor escaped by the three outside doors.

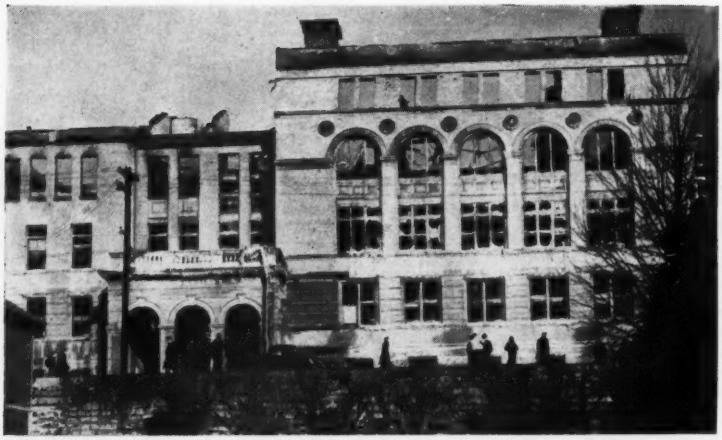
A costly silhouette against a background of red destruction was the result of a fire of unknown origin which completely involved Morrill Hall at the University of Tennessee before firemen arrived at 3 A.M. on January 18, 1934. Due to the advanced stage of the fire, eight hose streams proved futile, and over $93,000 loss resulted.

Of the 400 children nearly half were on the second floor. These, for the most part, escaped by means of the slide fire escape. From ten to twenty, it is estimated, came down through the smoke on the stairs and left by the front door.

Fire drills, which are said to have been held frequently during the fall, doubtless aided in making it possible for the principal to control the pupils and avert a panic. By coolness of speech and action he prevented a rush for exits, and as pupils emerged from rooms, he indicated exits to be used. The time required to empty the building is estimated at less than three minutes. The fire spread so rapidly that nothing was saved.

PUBLIC SCHOOL, FAYETTEVILLE, GA., OCTOBER 22, 1937. A teacher noticed smoke rising from the basement. She told her second grade pupils that it was time for a fire drill, and all classes in the building were notified. The pupils marched out quietly, none suspecting the true reason for the drill. Shortly after all the pupils had left the building, flames burst through and destroyed the two-story structure.

PUBLIC SCHOOL, LOWELL, MASS., APRIL 7, 1938. Seven hundred children marched quickly and quietly to the street, fire drill fashion, when the roof of a grammar school caught fire and filled the building with smoke. The fire was extinguished by firemen with only slight damage, whereupon the children returned to their desks.



Donald Barton Studio.

Ruins of Fitchburg, Mass., High School, destroyed December 15, 1934, with $600,000 uninsured loss. One fireman was killed and two were injured while at work on the débris. A school official is quoted as saying that the building was not insured because of the "unlikelihood of fire." For some years the fire department had recommended automatic sprinklers in the basement and roof space, but no sprinklers were installed. This picture was taken from a lower level looking at the front of the building. The entrance to the building shown in the picture was one of two leading from the street to the upper floor where the fire started.

Fires in Schools with Automatic Sprinklers.

Schools protected by automatic sprinklers have enjoyed the very favorable fire record which may be expected from this form of protection. According to the records of the N.F.P.A. Department of Fire Record, sprinklers have controlled 92.1 per cent of the fires in which they have operated. However, this is obviously a very conservative estimate of the efficiency of sprinklers in school fires. Sprinklers frequently extinguish incipient fires through the operation of one or two sprinkler heads. Where there is no loss to be reported, most of these small fires do not come to the attention of the N.F.P.A. and therefore cannot be included in the sprinkler efficiency tables. Also some school officials undoubtedly fail to report small fires because they do not wish to publicize the fact that a fire has occurred in their school. Could all of the fires controlled by sprinklers be included in the records, the satisfactory performance of sprinklers in school fires would be nearer 100.0 per cent.

Out of the seventy-six school fires reported to the N.F.P.A. in which sprinklers operated, there was no case where a standard sprinkler system, when in service and backed by a reasonably good water supply, failed to check or control a school fire. However, there were six fires where the sprinkler performance was unsatisfactory. In two cases the water supplies for the sprinklers

San Francisco Police Dept.

Portion of damaged roof of San Francisco Girls' High School, showing effect of heat on the unprotected steel roof structure. The fire gained great headway before being discovered because the windows were covered during remodeling designed to provide resistance against earthquake.

were shut off, once by an incendiary, and once to prevent freezing of sprinkler piping in an unheated area. Two other fires gained their initial headway in portions of buildings not protected by sprinklers. Another fire occurred in a building of such inferior construction that the partial sprinkler system with which the building was equipped could not have been expected to control the fire. The remaining unsatisfactory sprinkler fire occurred in a rural area where a very limited water supply for sprinklers was exhausted before additional water could be obtained through long hose lines.

Summary of Sprinkler Efficiency.
(1897-1939, inclusive.)

	No. Fires	Per Cent
Practically or entirely extinguished fire	55	72.4
Held fire in check	15	19.7
Total where performance was satisfactory	70	92.1
Unsatisfactory	6	7.9
Total	76	100.0

Effect of Sprinklers.
(1897-1939, inclusive.)

	Colleges and Universities	Public Schools	Private Schools	Trade Schools
Extinguished fire	23	9	8	15
Held fire in check	5	5	3	2
Total satisfactory	28	14	11	17
Failed to extinguish fire	0	3	1	2
Total	28	17	12	19

"Built-to-burn" construction, a high wind, inadequate private fire protection, and a low water pressure were all factors which permitted a seemingly insignificant blaze in the roof space to sweep through the entire structure of the Polish National Alliance College in less than two hours' time on January 20, 1931.

Below are given some typical reports of fires in which sprinklers operated.

TEXTILE SCHOOL, LOWELL, MASS., MARCH 9, 1925. Fire occurred in the chemical laboratory. It started in a wooden case with glass doors used for the storage of various inorganic chemicals and was probably due to spontaneous ignition of yellow phosphorus. One sprinkler operated and practically extinguished the fire. The public fire department used a chemical extinguisher to complete the extinguishment. The fire loss was negligible. Water damage amounted to $800.

COLLEGE, CAMBRIDGE, MASS., APRIL 13, 1926. Fire started in a chemical laboratory building of fire-resistive construction. Rubber tubing became disconnected from a gas burner and ignited the woodwork of the laboratory bench. One sprinkler operated and a foam extinguisher was used to assist in extinguishing the fire. The loss was negligible.

PRIVATE SCHOOL, RYE BEACH, N. H., DEC. 5, 1926. A student in a private school for girls tried to burn some waste material in a fireplace. She was unsuccessful, so she carried it to a maid's service closet and threw it into a metal waste barrel containing paper and rubbish, but did not replace the cover on the barrel. A short time later a fire occurred. One sprinkler operated and extinguished the fire, and the sprinkler alarm gave immediate notification. The fire happened at the time when the school engineer was lecturing to the teachers and girls on the merits of the sprinkler system and the necessity of keeping the windows closed on cold nights to prevent freezing of the sprinkler pipes. The fire appropriately furnished an excellent example of sprinkler efficiency.

PRIVATE SCHOOL, SHEFFIELD, MASS., APRIL 29, 1928. A large meal bag more or less soaked with grease had been used by a cook around the kitchen stove, the top of which was red hot. The bag was then thrown into a large

Keystone View.

Loss reported to exceed $100,000 resulted when the Perley Free School at Georgetown, Mass., was destroyed on January 28, 1935. In many small communities a school fire is a most serious problem for the fire department.

cardboard carton located in a corner of a small vestibule used as a storeroom for garbage and rubbish. A spark from the stove evidently smoldered unnoticed in the bag, which soon burst into flame. The fire was not observed until the cook heard the hiss of air from the opened sprinkler, which quickly extinguished the fire.

College, Montreal, P. Q., Feb. 27, 1929. Fire occurred in the janitor's quarters in the basement of the Redpath Library at McGill University, probably due to the spontaneous ignition of oily materials or the careless disposition of a match. The basement was equipped with automatic sprinklers, one of which operated and extinguished the fire with but minor damage.

Private School, Groton, Mass., Jan. 14, 1929. Fire occurred in a brick waste paper chute extending from the basement to the second floor of a large dormitory building. The chute had openings at each floor protected by iron doors, and it is thought that a student may have thrown a cigarette stub or match into the chute. When a maid working on the second floor opened the chute door she was met by a blast of smoke and heat, which was prevented from extending into the corridor by the operation of two sprinklers. Since the fire, sprinklers have been installed in the two waste paper chutes in the building.

High School, Lynn, Mass., Nov. 14, 1929. Automatic sprinklers, recently installed, were factors in extinguishing a fire which occurred shortly after midnight in some rubbish in the boiler room. One sprinkler operated and extinguished the fire before firemen, summoned by the sprinkler alarm, reached the scene.

College, Rochester, N. Y., Feb. 13, 1929. A fire occurred in the dressing room of the theatre of the University of Rochester when a woman was

Fire in McDonough School, Baltimore County near Pikesville, Maryland. Fire spread throughout building by means of vertical openings. The hose of six companies was used to bring water from a small river for one stream. Five pumpers were used in relay to provide the pressure.

cleaning a dress with gasoline. Two sprinklers opened and confined the fire to the room of origin with slight loss.

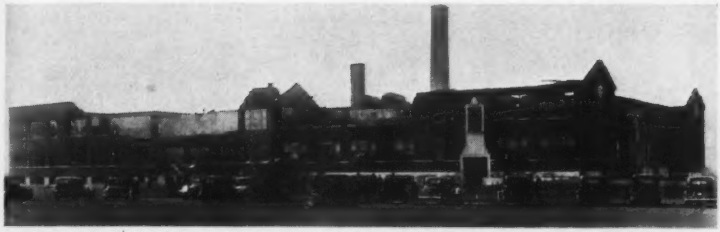
GRADE SCHOOL, PORTERDALE, GA., AUG. 25, 1930. A fire, due to the spontaneous ignition of an oily floor mop, broke out in a closet at 4 A.M. in the schoolhouse of a mill village. The operation of an automatic sprinkler resulted in the prompt extinguishment of the fire with a loss of $130.60.

PUBLIC SCHOOL, SOUTH MANCHESTER, CONN., JAN. 4, 1932. Spontaneous ignition occurred in a wicker hamper containing sweepings, rags and other refuse. The fire was confined to the hamper and closet, and was extinguished by one sprinkler.

PRIVATE SCHOOL, DEERFIELD, MASS., DEC. 19, 1932. Either a spark or a tongue of flame from a fire which was burning in a living room fireplace ignited books and papers on a built-in shelf at the side of the fireplace. The resulting fire burned a portion of the bookshelf and scorched a window casing, at which point two sprinklers opened and extinguished the blaze.

COLLEGE, ITHACA, N. Y., JAN. 27, 1933. A fire occurred in the waste paper chute in a women's dormitory at Sage College. It was believed to have been caused by a burning cigarette. A sprinkler head at the top of the chute opened and put out the fire.

ART SCHOOL, CHICAGO, ILL., DEC. 23, 1933. Fire occurred in the box storage room in the basement of a fire-resistive building, probably due to spontaneous ignition of paper carton material and baskets. Two sprinkler heads opened and extinguished the fire.



Due to the delayed discovery of the fire which had spread through a combustible roof space, the Thornton Fractional Township High School at Calumet City, Illinois, was practically destroyed by fire on December 20, 1934, with a loss of $420,000. Except for the combustible roof area, the main building was largely of fire-resistive construction.

COLLEGE, MONTREAL, P. Q., JAN. 7, 1934. Automatic sprinklers extinguished a fire which started among bales of waste paper in the basement waste paper baling room with a very small loss. It is interesting to note that a few years before the sprinklers were installed, a fire occurred in the same waste paper baling department, necessitating the use of several hose streams and causing considerable trouble to the fire department because of smoke and difficulty in reaching the flames.

SCHOOL OF PHOTOGRAPHY, NEW YORK, N. Y., MARCH 20, 1934. Fire that occurred from an unknown cause in a small amount of scrap film in a metal container was entirely extinguished by the operation of one automatic sprinkler.

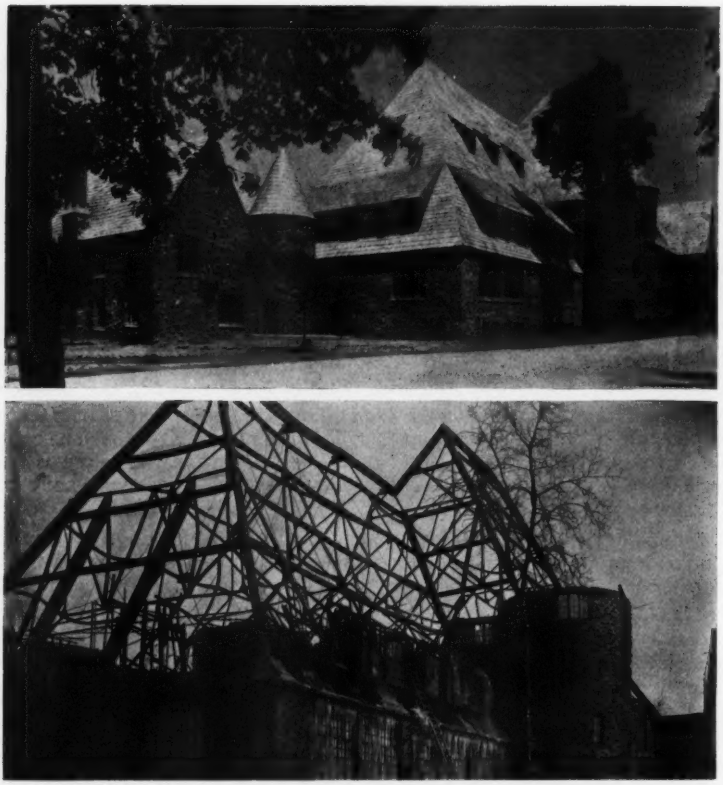
COLLEGE, PENNYAN, N. Y., JULY 4, 1934. A firecracker ignited a window drape in the reception room of Neuka College. Two sprinkler heads operated promptly and extinguished the fire. Damage limited to $250.00.

COLLEGE, SOUTH HADLEY, MASS., OCT. 24, 1934. A maid carelessly placed hot ashes, removed from a fireplace, in a metal barrel partly filled with combustible waste, and located in a small utility closet on the first floor of a dormitory. Ashes ignited the waste and fused a sprinkler in the closet, which completely extinguished the fire before loss occurred.

UNIVERSITY, NEW YORK, N. Y., MARCH 12, 1937. Fire occurred in a chemistry laboratory when the fumes from a volatile chemical mixture were ignited by a gas stove. One sprinkler head operated and extinguished the flames.

Large Loss Fires in Fire-Resistive Schools.

Fire protection authorities have long recognized that fire-resistive construction alone does not give adequate fire safety, as there are enough combustible contents and trim in any fire-resistive building to make a damaging fire, particularly in rural sections, where, because of inadequate water supply, even a comparatively slow burning fire may continue until serious damage has resulted. Also in buildings constructed principally of non-combustible materials there are found defects from a fire safety point of view which may cause almost complete destruction. Such defects include combustible attic or roof



Firemen's Fund Record.

The pictures show the Cascia Hall School of the Augustinian Fathers at Tulsa, Oklahoma, before and after a fire which practically ruined the structure on January 2, 1928. The building was of unusual design and was partly fire-resistive, with a roof of maximum pitch entirely of hand hewn shingles on steel supports. The building itself was of brick and concrete construction.

spaces, combustible ventilating ducts, lack of adequate protection for principal supporting members, or failure to safeguard equipment having an explosion hazard, as in the New London, Texas, disaster.

HIGH SCHOOL, WOODLAND, CAL., DEC. 31, 1923. This building had brick walls and concrete floors, but some wood joist interior construction. Fire occurred when an electric flat iron was left in circuit, causing a loss to the building and contents of $66,595. The insurance loss was but $19,000. The reason for the small amount of insurance on an investment of $192,000 was said to have been due to the belief on the part of the school trustees that a serious fire could not occur in this building.

The above desolation is not the aged ruins of Stonehenge, England, which it resembles, but the work of a fire which in a few hours destroyed St. Joseph's College at St. Joseph, New Brunswick, on October 20, 1933. A loss of $445,000 resulted.

PRIVATE SCHOOL, TULSA, OKLA., JAN. 2, 1928. The building involved in this fire was of unusual design, of brick and concrete construction, and fire-resistive except for the roof, which was of hand hewn wooden shingles on steel supports. The cause of the fire has not been definitely determined. Late in the afternoon of the fire a chore woman had been in the third story with a blow torch, which she used to thaw out some pipes that were apparently frozen; it is possible that in thawing the pipes she may have started a small fire in a concealed place, which, not being seen, developed into the fire which destroyed the roof and upper floor. The loss is estimated at more than $50,000, or approximately 30% of the cost of building.

COLLEGE, WILLIAMSBURG, VA., MARCH 15, 1930. The laboratory building involved was of fire-resistive construction except for an open joisted slate roof. The fire-resistive floor slab directly below the roof space was pierced by an elevator shaft and a clock pendulum shaft. The fire started in an elevator which was being used by the janitor while cleaning the building. He had deposited the trash from the basement and first floor on the elevator, which was at the second floor level while that floor was being cleaned. Among the trash were three large bottles of waste chemicals. Heating of these chemicals is believed to have ignited the waste paper. A small explosion attracted the attention of a professor, who found the elevator on fire. The fire was already beyond the control of the hand extinguishers which were used by several students. Inadequate water supply and dense smoke hampered the work of the firemen, and the building was largely destroyed above the second floor level. The roof was destroyed and the heat caused the fire-resistive slab beneath to expand, pushing the walls above the second floor level out of place so that the building had to be rebuilt from that level up. Damage amounted to nearly $67,000.

HIGH SCHOOL, GOEHNER, NEB., MAY 17, 1935. This building is reported to have been of partially fire-resistive construction. Defective electrical wiring is believed to have caused this fire, which destroyed the interior of the building with a loss estimated at $70,000.

COLLEGE, SYRACUSE, N. Y., JAN. 1, 1937. This building was a three-story fire-resistive structure except for the roof, which was of wood joist construction. The fire started in the attic space from an unknown cause and completely destroyed the roof. Water damage was very severe throughout the building, although the fire was largely confined to the area above the concrete floor of the attic. Irreplaceable museum exhibits on display in the building were lost. Damage amounted to $120,000.

COLLEGE, NEVADA, MO., AUG. 16, 1937. Only the first story of this building was of fire-resistive construction. As a consequence the fire, which started in some undetermined manner in a second-floor chemistry laboratory, had gained such headway that the entire upper floor was in flames when the fire apparatus arrived. The loss amounted to $30,500.

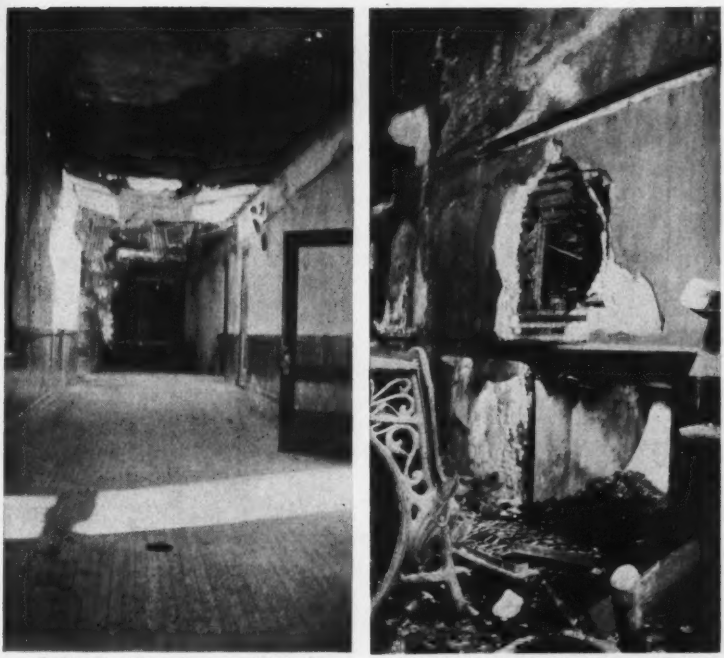
NOTE: In addition to the large loss fires described here, several other fires involving large losses in fire-resistive buildings have been described under other classifications. These other fires include the New London, Texas, disaster; the gas explosion at Whitehurst Hall, Oklahoma A. & M. College; the Junior High School at Little Rock, Arkansas, and the Public School at Pipestone, Minnesota, both described under heating and ventilating duct fires.

Heating and Ventilating Ducts.

Ducts of ventilating and heating systems have been responsible for numerous fires spreading from a comparatively insignificant origin to cause serious loss or even total destruction of the school buildings in which they were employed. These systems are quite generally used in schools in order to provide continuous circulation of air at a given temperature without the discomfort of cold drafts and waste of heat, resulting when fresh air is brought directly inside through windows. Probably the most general arrangement has utilized a double system of ducts connected to each room. The air, freshly heated, is delivered through a register near the floor and foul air is eliminated through a register near the ceiling, connected to ducts which quite frequently discharge into an open attic over the building. An arrangement by which the ducts discharge into an open attic is a very serious defect, as fires have frequently gained great headway in the attic space before being discovered, destroying the attic and roof. Embers often drop down ducts and start fires in other rooms. The following fires are typical of the many fires in which heating and ventilating ducts played a major part.

Fires Involving Attic Spaces.

INTERMEDIATE SCHOOL, EVANSTON, ILL., JAN. 9, 1927. Fire of unknown origin was discovered in the manual training room in the basement at 2:02 P.M. The building was of brick-joisted construction, two stories in height. Unprotected air shafts extended from the basement to a large open attic over the entire building. The fire had considerable headway when the fire

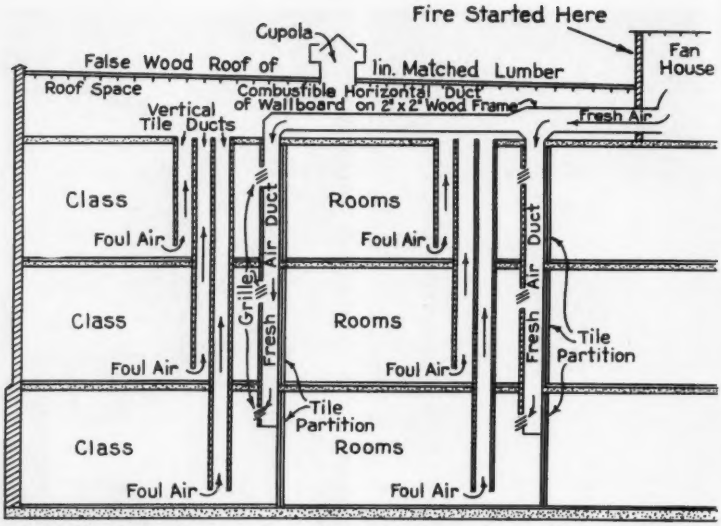


Left: Looking along a third floor corridor of the Little Rock High School toward open stairway in the background. Note failure of metal lath and plaster ceiling below the blind attic. Right: Bottom opening of one of the ventilating ducts, through which fire of November 10, 1932, spread from the blind attic.

department arrived. Hose lines were taken inside and the fire in the basement practically brought under control, but the fire had already traveled up an unprotected air shaft and involved the large open attic. As the roof and top floor showed signs of collapse, hose lines were withdrawn and the fire was fought from the outside with the assistance of eleven fire companies.

HIGH AND GRADE SCHOOL, MAYSVILLE, MO., APRIL 4, 1931. Fire occurred from defective wiring in the ceiling of the first floor. It spread rapidly to other parts of the building by means of the metal ventilating shafts, which opened directly into the cockloft. The loss was nearly total and amounted to $85,340.

JUNIOR HIGH SCHOOL, LITTLE ROCK, ARK., NOV. 10, 1932. Fire occurred in a three-story partly fire-resistive building having brick exterior walls, metal lath and plaster partitions, and concrete floors. The roof was of wood covered with built-up composition, tar and gravel. Floors were supported in part by unprotected cast iron columns and in part by reinforced concrete columns. The ceiling of the top floor was metal lath and plaster on metal joists. Between this ceiling and the wooden roof was a three-foot blind attic. In older portions of the building the roof was supported by wooden trusses and in the new section by unprotected steel trusses. The building was heated by a



Substandard arrangement of the ventilating system played an important part in the $150,000 loss in the public school at Pipestone, Minnesota. Combustible fresh air ducts from the fan house spread the fire through the roof space. As vertical air ducts were without dampers and terminated in the roof space, the fire readily spread downward through the ducts to all floors of the building.

hot air system and each room, in addition to a hot air duct, had an independent metal ventilator duct that terminated at the ceiling line in the attic. These ducts were built side by side, and in places there was a continuous area of ducts twelve feet long.

The fire was discovered in the office on the first floor and was probably caused by an overheated furnace, as the temperature was low and the furnace was being forced to heat the building for an evening meeting. The fire had considerable headway when discovered and was burning in two rooms on the first floor. Shortly after the fire department arrived, fire was discovered in the attic space. Burning embers dropped down the ventilating shafts, starting fires in various rooms. Two-thirds of the roof was burned off. The loss was estimated at $40,000 to $50,000. (See January 1933 QUARTERLY, page 247.)

ROME FREE ACADEMY, ROME, N. Y., APRIL 28, 1938. A fire occurring in some waste paper in the basement was conveyed to the attic by means of air ducts. A wooden roof covered this otherwise fire-resistive building and the loss was about 50%, which amounted to $141,875.43.

PUBLIC GRADE AND HIGH SCHOOL, PIPESTONE, MINN., MARCH 17, 1939. Fire was discovered about 11 A.M., when smoke was observed coming from a fresh air grille in the hallway. The janitor traced the fire to the ventilating fan pent house, but, because of the heat, was unable to reach the control room to shut off the fans. Due to an efficient fire drilll, 1200 students and 47 teachers left the building in an orderly manner. The building was of three-

Ruins of Western High School, Detroit, showing ice-covered walls, all that remained after a fire of apparently incendiary origin swept the building on February 25, 1935. Ventilating ducts which honeycombed the building spread the fire to all parts of the structure, causing $582,202 loss.

story fire-resistive construction, but had a wooden false roof under which combustible ventilating ducts extended to vertical air ducts leading to the classrooms. When the fire department arrived the combustible roof structure was ablaze and flames from a fresh air duct had ignited the third floor library. Other small fires occurred throughout the building due to combustible materials from the roof dropping down the ducts. The most serious of these ignited the janitors' supply room and spread to the adjacent hallway. Considerable water damage resulted from use of hose streams in fighting the roof fire and smaller fires throughout the building. The total loss was about $150,000. (See July, 1939, QUARTERLY, page 68.)

False Ceilings and Blind Spaces.

In some installations the hazards of inaccessible open spaces are not confined to attic or roof areas, but are created by having vertical shafts or ducts discharge into or pass through open spaces created by means of false ceilings or floors. Such an arrangement greatly increases the likelihood of severe fire losses, as fire can spread through such an area practically unrestricted.

PUBLIC SCHOOL NO. 110, BALTIMORE, MD., JANUARY 11, 1920. Fire started in the furnace room in the basement, caused by hot ashes deposited in a metal container on a wooden platform. The building was of brick-joisted construction. The principal structural features responsible for the rapid spread of the fire were the enclosed rear stair well and the ventilating ducts in each

first and second floor corridor, which opened into the stair well. These ducts, about 6 ft. high, were formed by false ceilings of lath and plaster and sheathing. The ventilating ducts were connected with classrooms by ordinary cast iron registers. The fire was discovered at 6:18 P.M. in the basement adjacent to the enclosed stair well and spread rapidly upward by way of the stair well and into the corridor ventilating space and up into the large blind attic. The fire was confined to these areas but was very difficult to extinguish. Considerable loss resulted.

HIGH SCHOOL, DETROIT, MICH., FEBRUARY 25, 1935. The main building was of brick-joisted construction two and three stories in height. When the school was built, a three-foot space was left between the ceilings and floors above for ventilating ducts. Ducts were also installed in vertical partitions. This type of construction contributed materially to the spread of the fire. The fire, which was of incendiary origin, was discovered on the first floor by the night janitor, who was endeavoring to locate the source of smoke. He ran down the stairway to the basement and out through the rear of the building to his home, about one block from the school, from which he called the fire department by telephone. This call was received at 11:52 P.M. A city fire alarm box inside the building, within fifteen feet of where the janitor was standing when he discovered the fire, was forgotten in the janitor's excitement.

The first engine company to arrive entered the building with a chemical line and first aid equipment, as there was no evidence of fire from the outside. They extinguished the blaze at the end of the row of lockers and discovered, meanwhile, another fire burning beneath a teacher's desk in a near-by classroom. While this latter incipient fire was being extinguished, two more similar fires were discovered under teachers' desks in adjoining classrooms. Another fire was then discovered at the far end of the corridor in a classroom at the extreme southeast corner of the building. This fire had apparently gained access to the ventilating ducts and had spread to the attic. Five alarms were sounded, but the fire spread rapidly and practically destroyed the building. The loss was $582,702. (See April 1935 QUARTERLY, page 329.)

Blower Fans Spread Fire.

The following fires illustrate how rapily a fire may spread where fans are in operation. Fortunately no lives were lost in these fires.

GRAMMAR SCHOOL, LONG BEACH, CALIF., DECEMBER 27, 1918. A defective heating system was responsible for a fire which started in the basement of this 2-story frame, brick-veneer building while 600 pupils were attending classes. The alarm was promptly sounded and the building was vacated in two minutes. The flames which filled the furnace room were communicated to all parts of the building by a motor driven fan provided to force the hot air through the pipes of the heating system. When the fire department arrived the fire had spread to all floors, and was coming through the roof. The loss, $44,086, was practically total.

HIGH SCHOOL, KANSAS CITY, KAN., MARCH 3, 1934. The building was of three-story, brick-joisted construction with corridor walls of brick and stone. There was a common roof space over the entire building. Six open stairways extended from the basement to the third floor. The heating and ventilating equipment was a hot blast indirect heating system, with distribution through

galvanized iron ducts and brick stacks. Fresh air intakes for the center section were from openings in the front of the building extending to the fans by tunnels beneath the basement floor. Air intake for the north and south wings was through ducts in the concrete ceiling over fan and ventilating rooms. The foul air system for the center section was down-draft to brick, wood top tunnels three feet high under the basement corridors discharging by fans into brick stacks at the rear. These corridors were from eight to twelve feet in width. The tunnels beneath had brick and stone side walls, and the corridor floors above, of wooden sheathing on wooden joists, formed their ceiling. There was three inches of concrete without reinforcement over the sheathing. Two brick stacks in the auditorium ended in the attic, with tops closed by heavy wooden traps. The foul air systems for the wings exhausted through roof vents. Steam for the heating coils was supplied by oil fired boilers in the center section.

The fire was first noticed in the basement corridor in a pasteboard box containing waste paper. The night engineer and janitor thought that they had extinguished the rubbish fire, but a few minutes later smelled smoke and called the fire department at 4:45 P.M. When the firemen arrived there was a little smoke but no fire visible. They chopped the baseboard and the partition at the point where the waste paper box fire had occurred, but found no fire. Back of the baseboard there was a small hole in the floor, opening into a space formed by the brick wall, floor joist and two headers over the tunnel. The underside of the flooring was considerably burned. The fire was next noticed through the glass panel door of the foul air fan room. By this time the smoke was quite dense and men were sent to upper floors to ventilate. They returned and reported fire in various rooms on upper floors. The firemen were then ordered from the building. Before they could get out, part of the floor in the main basement corridor over the tunnel collapsed, nearly trapping several men. When the ventilating fans were shut down, the fire traveled in both directions through air tunnels, discharging through the foul air registers into rooms and halls of the center section. A wooden stairway extending from the basement directly over the fan room to the top floor allowed the fire to spread rapidly into the attic. Fire spread down from the attic into the auditorium through foul air ducts. The attic, roof, third floor, and auditorium were destroyed. During the fire eleven engine companies were in action, including two from Kansas City, Mo. The loss was $265,809.

Ducts of Combustible Construction.

The danger of heating and ventilating systems contributing to the spread of fire has been materially increased in some cases by constructing ventilating ducts of wood. The wooden ducts, thoroughly dried by the hot air, carry fire through inaccessible wall and floor spaces, making it practically impossible to control. The three following fires in which schools were destroyed show the result of this type of construction. Fortunately classes were not in session.

HIGH SCHOOL, MCALESTER, OKLA., JANUARY 15, 1919. Fire of unknown origin was discovered at 3:45 A.M. in the basement of the brick and stone-joisted building. Fire spread by means of a wooden flue ventilating system which extended from the basement to all parts of the building. The loss was estimated at $91,000.

P. & A. Photo.

The Franklin Preparatory School, Cincinnati, Ohio, was destroyed by fire on February 1, 1926, with a loss estimated at $75,000. The fire started in the furnace room of this fifty-year-old frame building and spread rapidly to the upper stories. No one was in the building at the time.

PUBLIC SCHOOL, FREEMAN, S. D., OCTOBER 13, 1923. Fire started from an undetermined cause at 4:30 P.M. while a few children and teachers were in the building. The building was a two-story frame structure of six rooms. The fire started in the basement in a wooden ventilating shaft and spread through the building by means of the shaft. When the fire department arrived, the structure was filled with smoke and it was difficult to locate the fire. The school was destroyed.

HIGH SCHOOL, CHARLESTON, ILL., JANUARY 4, 1927. Fire due to defective wiring originated in the basement of the brick-joisted building at 9:30 P.M. When the fire department arrived the firemen could not locate the fire at first, but finally found it working up from the basement through wood lined ventilators. The fire went from the basement to the roof by way of these ventilators and then burned down. The loss was $101,000.

Rubbish in Vent Ducts.

Where poor housekeeping prevails, vent ducts are apt to become receptacles for rubbish or dust which may provide fuel for a chance spark entering the ducts. Even when fire does not originate in the rubbish deposited in the vent ducts it may ignite from the heat and sparks from a fire starting elsewhere in the building and cause the fire to spread through the ventilating system. The following fires show what may be expected when ducts are not kept clean or are allowed to deteriorate.

PUBLIC SCHOOL, PERRY, ILL., JANUARY 31, 1930. Fire started on the first floor of the two and one-half story brick-joisted school building at midnight. Sparks from the chimney were blown into the ventilating shaft which was con-

nected to each room. It is thought that a considerable amount of dust and rubbish had accumulated at the bottom of the shaft, which ignited and caused the fire to spread quickly to all rooms. Inadequate fire protection facilities made efforts to save the building fruitless. The loss was $50,300.

PUBLIC SCHOOL, HARRAH, OKLA., MARCH 6, 1931. This fast spreading fire, previously reported in this record under exit drills, was chargeable to the condition of the heating ducts. Fire started in the basement while the heating system was being forced due to cold weather. The hot air was distributed by insulated metal ducts to registers in the floors. A teacher noticed flames in a register, dismissed her room and sounded an alarm. The building was emptied in a little over one minute. The last to leave said that the floors were hot and the smoke choking. The fire started in the heating system. It is not known whether deterioration of the metal ducts or ignition of rubbish in the registers caused the fire, but it spread so rapidly that practically nothing was saved.

Fire or Smoke From Outside Sources.

The danger of exposure fires entering ducts makes the following fire of interest.

PUBLIC SCHOOL, WALNUT SPRINGS, TEX., MARCH 12, 1920. Fire attributed to careless smoking occurred in a pile of kindling wood outside of the two-story, brick-joisted building. The wind carried sparks and flames into a ventilator opening, igniting the first floor of the building. The building was destroyed with a loss of $40,000.

Motion Picture Film Fires in Schools.

Fortunately no serious school fire disasters have been reported in the United States and Canada due to ignition of motion picture film. This would indicate that in most schools where motion pictures are regularly used the importance of having a proper booth and trained operators is recognized. In only one fire, which occurred in 1920, was dangerous nitrocellulose film used in a school without a booth.

ELEMENTARY SCHOOL, SEATTLE, WASH., MAY 14, 1920. A 1000-foot reel of standard nitrocellulose film was being used in a small motion picture machine without a fire-resistive booth. The automatic shutter over the aperture had become stuck in an open position and this exposed the stationary film to the rays from the 400-watt lamp. This caused the film to take fire. The blazing machine was carried through the room and thrown outside the building. The audience of children were badly frightened but panic was fortunately averted. The loss, which was small, was confined to the film and the machine.

ELEMENTARY SCHOOL, STERLING, KAN., NOV. 1, 1921. A slow-burning type film was being shown before approximately 100 children. The janitor had been repairing the machine and there was one piece that he could not get into its proper place, and as the class was ready they decided to leave the piece out. While the janitor and one of the older boys were operating the machine the film caught fire. The machine was badly damaged and the piano on which the machine was set was slightly damaged. The children were marshaled from the building in safety.

COLLEGE, ROCHESTER, N. Y., Nov. 28, 1926. A fire which started in the projection room of a university building was caused by the ignition of motion picture film in one of the machines. Two sprinklers operated, and chemical extinguishers were used to assist in extinguishing the fire. Loss was between $300 and $500. This fire illustrates the value of standard arrangement and protection where motion pictures are to be shown in schools.

HIGH SCHOOL, NEW YORK, N. Y., MAY 17, 1929. Four hundred boys were in the auditorium watching the showing of an educational film when smoke was observed curling up from film on the floor of the booth. The boys were dismissed, while the operator left the booth and summoned the fire department. The fire was confined to the booth, which was of fire-resistive construction.

HIGH SCHOOL, NEW YORK, N. Y., MARCH 31, 1933. Fire occurred in the projection booth during the showing of an educational film. Mechanism designed to make the booth air-tight operated and extinguished the fire. The loss was slight.

HIGH SCHOOL, WASHINGTON, D. C., APRIL 12, 1935. A reel of film ignited in the projection booth due to overheating. It was extinguished by an electrician, who suffered minor burns on his hands and face.

Natural Gas Explosions.

As previously mentioned, explosions of natural gas have been responsible for at least three serious accidents involving school structures. The worst of these was the disaster which took 294 lives and completely demolished the Consolidated High School at New London, Texas, as reported earlier in these pages. Two other accidents that appear to have narrowly escaped fatal results are recorded below. These three occurrences in less than three years' time should serve as adequate warning that natural gas installations must be made in accordance with recognized safety practices by workmen trained in gas installations, and that natural gas should carry a malodorant to give warning of its presence.

It is also worthy of note that two of these gas explosions, including that at New London, Texas, occurred in buildings of fire-resistive construction. While fire-resistive construction is very desirable to prevent children from being trapped by flames, lack of combustible structural members may not alone provide complete safety if the building is so arranged that accumulations of escaping gas may explode beneath the structure and wreck the building.

COLLEGE, STILLWATER, OKLA., NOVEMBER 13, 1936. An explosion of natural gas severely damaged a three-story fire-resistive building known as Whitehurst Hall and occupied by college administrative offices, library, lecture rooms and laboratories of Oklahoma A. and M. College. The explosion was due to ignition of natural gas in a pipe tunnel under the building. The natural gas did not contain a malodorant and the odor of gas had not been observed on the day of the blast, although gas odors had been detected for several weeks prior to the fire. The explosion occurred when two student employees were about to

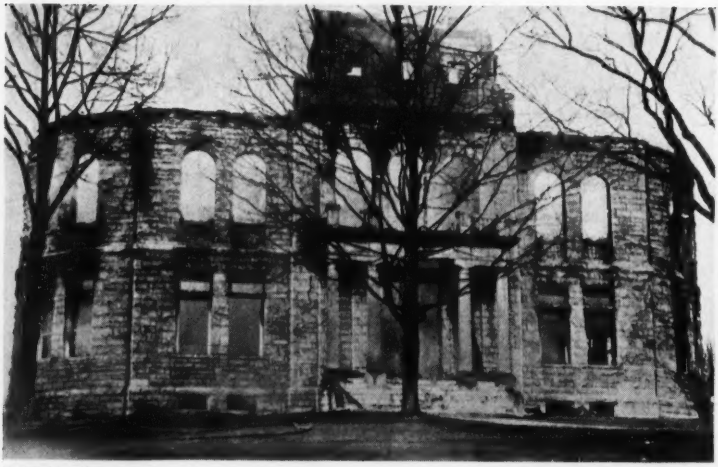
Acme.

This former dwelling in Barberton, Ohio, was in use as a temporary public school housing 101 students when wrecked by a gas explosion on May 31, 1939. Fifty-two children and four school employees were injured sufficiently to require hospital treatment. The second floor was dropped to the ground level, where outside supporting walls were blown out.

enter the pipe tunnel to repair an obstructed sewer drain. Apparently the bulb of an electric extension light became broken, igniting the gas. The greatest damage was to the east and north sections of the first floor, where the administrative offices and library were located. Of the twelve persons in the areas affected by the explosion five were injured. It is fortunate that the blast did not occur when the building was fully occupied and that the explosion was not severe enough to cause the collapse of the structure. While the explosion damage was confined to the first floor, it was considered advisable to replace the structure with a new building.

PUBLIC SCHOOL, BARBERTON, OHIO, MAY 31, 1939. Fifty-two children and four school employees were injured when natural gas explosions wrecked a former dwelling in use as a temporary public school at 1:30 P.M. on the day before the end of the school session. More than two score of victims were confined to the hospitals after the explosions and several were critically injured. It is fortunate that the disaster did not claim many lives. A small fire which started in the ruins was quickly extinguished.

The two-story frame building in which the explosion occurred was purchased as part of a school expansion program as the site for a new Central Graded School. Pending the erection of the new building the dwelling was being used as temporary quarters for three classes totaling 101 children of six or seven years old. Three teachers and the janitor were also in the building



International.

A valuable law library was destroyed when fire gutted Tucker Hall at Washington and Lee University, Lexington, Va., on December 16, 1934. The fire, possibly of incendiary origin, occurred while firemen were fighting another blaze.

and were among the injured.

The school janitor attempted to burn some papers in the furnace. When he struck a match a natural gas accumulation in the basement exploded with two distinct blasts at a very close interval. The first explosion seemed to raise the building from its foundation, throwing pupils from their seats and shattering walls and partitions throughout the structure. The second blast blew out the entire north end of the building and destroyed the floors. The weakened structure threatened to collapse on the injured children, who were struck by flying glass and débris or were thrown into the wreckage. A few children received burns as a corner of the building ignited from burning gas.

The teacher and most of the children in the first floor classroom were injured. Fortunately the central walls of the building remained largely in place and supported the roof. The second floor was held up in the center of the building, but fell downward where the outside walls were detached and thus acted as a slide which threw the upstairs children outside of the building with only minor injuries.

Neighbors and workmen on the near-by school construction job rushed to rescue the children. Most of the children were already on their way to hospitals when firemen reached the scene. Fire in one corner of the building was quickly extinguished, although the gas flame at the basement wall was not put out until the gas supply was shut off at the curb.

The natural gas involved in the explosion was not odorized, as it was considered to have enough natural odor to give reasonable warning in the event of a leak. No gas had been used in the building since the school authorities took possession, and the gas service was shut off at the meter. Workmen dug down to the gas service pipe and discovered a break in the pipe about eight

feet from the building wall. Apparently some gas had escaped from the break and followed the pipe into the building. The failure of the pipe may have resulted when a sewer excavation was made near by.

It is fortunate that a great loss of life did not occur. Had the building been of more substantial construction, confining the force of the blast and providing heavier débris, it seems likely that there would have been heavy toll of life. It is also fortunate that a serious fire did not occur before the injured were removed from the wreckage. (See July, 1939, QUARTERLY, page 71.)

Life Safety From School Fires.

By Robert S. Moulton, Secretary,
N.F.P.A. Committee on Safety to Life.

The Committee on Safety to Life of the National Fire Protection Association has since 1913 been studying the school fire situation and has incorporated in the Building Exits Code, the official standard of the National Fire Protection Association on this subject, a chapter outlining the fundamental requirements necessary for reasonable safety to life in school buildings. These recommendations were developed by a representative committee of experts, including fire protection authorities, architects, engineers, school administrators and others, which has studied school fire experience and finds that substantially all of the major loss of life in school fires in the past has been clearly due to violation of one or more of the cardinal principles of school fire safety as outlined in the Building Exits Code.

The Code recommendations are based upon the opinion of the committee that the material of building construction, while important, is less significant than various other factors of design and arrangement. A building can be constructed entirely of "fireproof" materials and still present a severe life hazard if the stairways are open to permit the rapid spread of fire and smoke, and if the combustible contents are not properly protected. The smoke hazard, in the opinion of the committee, is just as important, if not more important, as fire itself. The majority of fire deaths are due to the effects of smoke rather than actual burns, and even a relatively slight amount of smoke may cause a fatal panic.

In the Building Exits Code there are minimum requirements for character of construction based upon life safety considerations as distinguished from the usual type of fire regulation, which is based largely upon the preservation of property values. One of the first principles of construction, as enunciated by the committee, is that stairways and other vertical shaft openings must be enclosed so as to restrict the upward spread of fire and smoke and to afford a safe path of escape down the stairways for those on upper floors. The one-story school, so arranged as to afford direct access to the outside from any part of the building, is, in the opinion of the committee, the safest design, and when

this form of design is used there is little restriction as to the type of construction.

Exits should be so arranged that from any part of the building there will be at least two separate means of escape, so located that in case fire or smoke therefrom interferes with the use of one, another exit will be readily available. The exit details themselves are important. Stairs must be properly designed, doors must swing with the exit travel, handrails, lighting, etc., must conform with accepted standards. All these features are clearly specified in the Building Exits Code. Outside fire escapes are inferior in numerous respects to standard interior stair exits and are recognized by the Building Exits Code only as an expedient to rectify exit deficiency in existing buildings where the expense of providing additional interior stairways might be prohibitive.

Effective use of exits requires a fire alarm system of suitable type and a regularly organized fire drill. In fire drills the emphasis should be placed upon orderly controlled exit rather than speed alone. Drill procedure should be sufficiently flexible so that it can meet any emergency. For example, should a fire occur in or near a main exit, the children should be marched to some other exit. All these details are covered in principle in the Building Exits Code, but it must be left to the individual school authority to work out their application to individual school buildings, with due consideration to the arrangement of the individual building, character of the school population, and other factors.

Many schools contain rooms with hazardous occupancies. Special vocational and shop training may involve the use of highly combustible materials, making the hazard comparable with a factory. The Building Exits Code specifies that all such occupancies be properly segregated or protected, likewise that the heater and fuel storage rooms should be suitably cut off.

Existing buildings present a different and ordinarily more difficult problem than new construction. Some of the older school buildings, hazardous to life in their construction and arrangement, present a difficult problem because school authorities are often reluctant to make the expenditures necessary to safeguard such structures. The N.F.P.A. Committee on Safety to Life has likewise studied this special problem and has developed a section of the Building Exits Code which applies to existing school buildings, suggesting types of protective measures which can be applied to existing school buildings to give such degree of fire safety as can reasonably be required under such conditions. The installation of automatic sprinklers, either to protect the entire building or to cover the basements and particularly hazardous portions, is commonly the most practicable and least expensive method of mitigating the life hazard from fire in old fire-trap schools. Various other measures may be called for, depending upon the construction, arrangement and occupancy of the individual building.

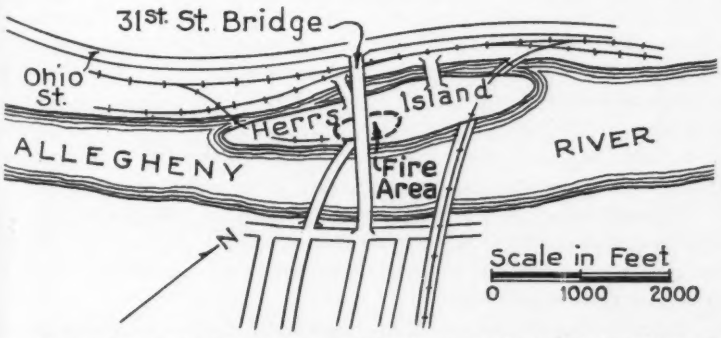
Union Stockyards Fire, Pittsburgh, Pa.

Report by William E. Patterson,
Secretary, Pittsburgh Bureau of Fire.

A "fireproof" structure with no combustible contents, a bulwark apparently invulnerable to any outside force, was damaged an estimated $100,000 by a Pittsburgh, Pa., stockyards fire on July 18th. The structure was the new Thirty-first Street highway bridge crossing the Allegheny River. It was supported on concrete piers high above Herrs Island, where were the Union Stockyards. Flames towering from the mass of wooden construction below heated the steel superstructure until it buckled; spalled and cracked the concrete roadway and piers. Meanwhile 133 firemen with nineteen pumpers, one deluge combination hose, turret and water tower wagon, two combination hose and turret wagons, two aerial and two city service ladder trucks were called to the fire by eight alarms. They extinguished it after it had burned over some 50,000 square feet with a loss of $60,000 worth of stockyard property.

Story of the Fire.

The first alarm from the island was given at 1:40 in the morning. When firemen arrived a few minutes later they found a large area already burning. The fire had started in a hay storage bin at the south end of the yards and spread rapidly. Several empty extinguishers lying around the yard gave evidence that employees had delayed the alarm until after they had tried to extinguish it with their own equipment. The battalion chief in command of the first companies went to turn in two additional alarms almost immediately. There was some little delay while he found fire alarm boxes on the island, con-



Map of Herrs Island. Note the accessibility of the fire to fire boat streams had the city possessed such equipment.

Ruins of stock pens near the point of origin of the fire. Firemen are shown drowning out remaining fire in loose hay.

nected by overhead wires, had been put out of service by the fire. Telephone lines to the island were burned out at the same time, and the alarms had to be transmitted from telephone stations on the mainland. Despite these handicaps there was a delay of only nine minutes between the first and third alarms. Two more alarms were given in quick succession about half an hour later, another forty minutes after that, and then two final ones at 3:20 and 3:23 A.M., nearly two hours after the first.

Twenty pumper streams, including an exceptionally powerful one that was operated from a deluge wagon on the Thirty-first Street bridge, and two booster tank streams were used on the fire. There are no city fire hydrants on the island. The water was obtained from private hydrants on an eight-inch fire main running the entire length of the island. This main is supplied from a 48-inch one running along Ohio Street, on the west side of the river. Most of the hydrants in the fire area were too hot for use when the first companies arrived, so long lines and relay pumping had to be used.

A complication in fire fighting was provided by 600 steers, hogs and sheep that were turned loose from the burning pens by employees. Firemen were forced to use valuable time and water driving them to the far end of the island with their hose streams.

Using the heavy concentration of equipment, firemen were able to save several severely exposed properties. Six one-story brick hay barns containing 372 tons of baled hay and a two-story reinforced concrete wooden roofed

This picture was taken from the mainland side of the back channel and shows the wide area involved early in the fire.

building of 20,000 sq. ft. floor area were directly across a twenty foot driveway. They were located along the back channel side of the island. The concrete building housed 800 head of sheep and calves. These exposures were saved, even though many window frames were ignited and badly charred or burned out. Automatic sprinklers inside the six hay barns operated with good effect. Two dangerous exposures, a large packing plant on the south end, and a rendering plant using large quantities of flammable liquids on the north end of the island, escaped ignition entirely, even though subjected to a constant shower of sparks.

When the fire was out, three-quarters of the large stockyards had burned, ten animals had been lost, and the bridge that hung overhead like a spit above a fireplace was made totally unserviceable and will be closed for laborious repair work.

Conclusions.

This fire illustrates again the serious consequences of delaying a public fire alarm, especially in areas of combustible construction, where a fire can get out of control rapidly and large values are at stake. It shows the limitations of overhead wiring for fire alarm systems.

Though there was no lack of equipment to fight this fire, the department could have made good use of a fire boat's heavy streams. The manuverability of a fire boat would have been a valuable asset in covering the waterfront.

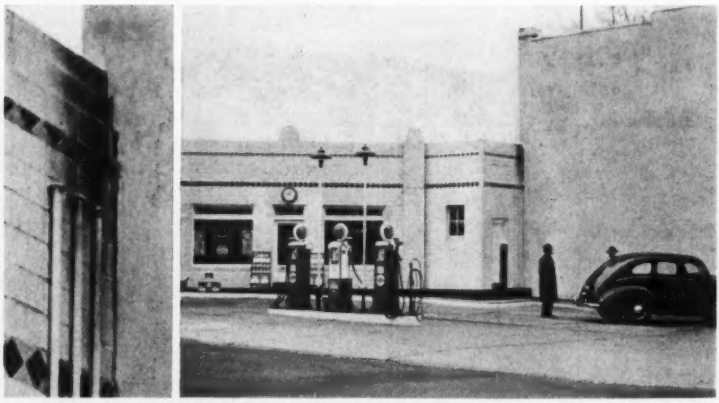
The interesting site of this fire indicates a possible use of automatic sprinklers or water curtains on even a totally non-combustible bridge. Had there been such water protection to keep the bridge members cool, a large proportion of the loss might have been avoided.

Two Interesting Filling Station Fires.

On March 14, 1939, a gasoline explosion occurred at a Baltimore, Md., filling station under rather unusual circumstances.* The service station, as can be seen in the illustration below, adjoins a two-story dwelling. The site of the station was formerly occupied by two similar buildings which, together with the remaining dwelling, were separated from each other by ordinary brick division walls. When two of the three dwellings were demolished to make room for the filling station, it was found that the dividing wall, which then became the outside wall, was only four inches in thickness. In order to seal and strengthen this wall it was given a coating of plaster.

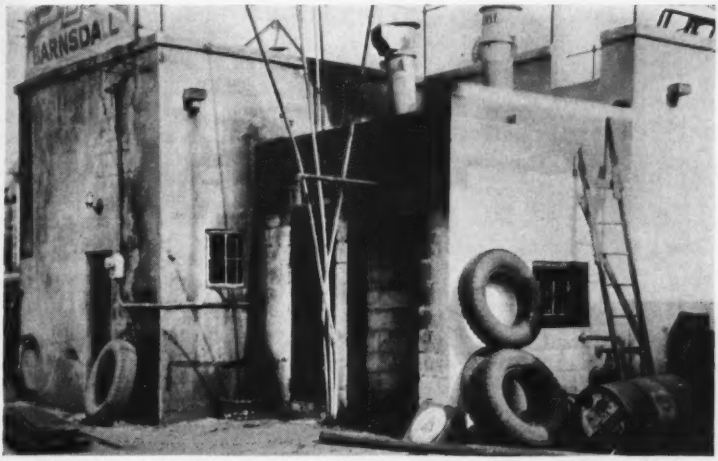
When the equipment for the filling station was installed, the vent pipes of the underground gasoline tanks were terminated below the parapet wall of the filling station because of the fact that the chimney of the adjacent dwelling is located at the rear corner immediately adjoining the station.

Directly following the explosion, eyewitnesses reported flame at the ends of the tank vent pipes. The explosion was of a minor nature, though it did disrupt part of the chimney. Subsequent investigation revealed that this chimney was of four-inch unlined brick construction and that, due to settling or other movement of the building, there were cracks extending from the junc-



Filling station at Baltimore, Md., where gasoline fumes were ignited by the faulty chimney of an adjoining dwelling. Close-up view at left shows tank vents following the explosion and the crack at the junction of the two buildings. This fissure, caused by settling of the dwelling, passed through the brick wall of the unlined chimney.

*Note: This account is based upon a report submitted by Harold L. Miner, Chairman of the N.F.P.A. Committee on Flammable Liquids.



Rear view of the filling station at Wichita, Kans., where a fatal gasoline flash fire occurred on August 16, 1939. The motor and pump house is the lower cement block structure shown above, pump room at the right, motor room at the left. The tank vent pipes shown at the center terminate about six feet above the roof and were distorted by the heat of the fire.

tion of the service station and dwelling wall directly into the chimney. As a result, while the tanks were being filled, the wind carried the explosive vapors into the chimney, where they were ignited by the stove in the kitchen. The flame traveled up the chimney, through the crevices, and ignited the vapors which were issuing from the vent pipes.

To avoid a repetition of such an explosion, with possible greater damage, it was proposed to relocate the vent pipes, carrying them to the right along the dwelling wall and terminating at a point above the automobile shown in the illustration. The vents would be located several feet above the roof of the filling station but below the parapet roof of the dwelling.

This explosion serves to emphasize the care which should be exercised in locating gasoline tanks and their vents near other buildings, and the need for thorough inspection of buildings following major structural changes.

Wichita, Kans., Filling Station Fire.

On August 16, 1939, a gasoline flash fire occurred at a Wichita, Kans., filling station, which fatally burned the attendant.† The lone night employee was in the process of filling one of three 550-gallon underground gasoline tanks from an 8000-gallon underground tank. The transfer was made by means of an electrically operated pump located in a small motor and pump house attached

†Note: This account is based upon a report submitted by Ewing B. Fergus, Manager of the Wichita Branch of the Kansas Inspection Bureau.

to the rear of the station. He neglected to watch the filling process and apparently pumped some 700 gallons, or 150 gallons more than the capacity of the smaller tank. As there was no open gauge or filling opening, the excess gasoline was forced up the one-inch vent pipe which terminated about six feet above the roof of the building, whence it sprayed and flowed down over the side of the building on to the ground.

A pedestrian called the attention of the attendant to the gasoline which was running into the street. The latter then proceeded to throw the pump out of gear and shut off the motor. In order to do this he was forced to wade through the accumulation of gasoline on the ground, and the gasoline which was flowing down from the vent pipe above the roof saturated his clothing. It is believed that an arc, which occurred when he pulled the motor switch, ignited the gasoline vapors.

The flash fire which followed resulted in the death of the attendant, considerable damage to the station and severe damage to two trucks and a trailer which were parked near by.

The negligence of the attendant in failing to watch closely the transfer of gasoline from one tank to the other resulted in his own undoing. Careful and uninterrupted supervision of pumps in operation must be maintained to avoid just such tragedies as this. This fire also calls attention to the necessity of explosion proof electrical equipment where explosive vapors may be found.

Fires in Which There Was Loss of Life.

Third Quarter, 1939.

Since the publication of the July, 1939, QUARTERLY, the N.F.P.A. Department of Fire Record has received reports of one hundred and five fires in which there was loss of life. Two hundred persons died as a result of these fires. During this period the following fires were reported in the United States, which resulted in the death of five or more persons each.

JULY 14, 1939, PROVIDENCE, KY. A dust explosion in a coal mine resulted in death to twenty-eight miners. Ten other miners also trapped by the blast were rescued. Carbon monoxide gas released by the explosion was the immediate cause of death. (L-5730.)

AUGUST 5, 1939, LONG ISLAND CITY, N. Y. Five men, four of them brothers, were burned to death and a sixth man seriously injured by an explosion which occurred while they were scouring a garage floor with gasoline. (L-5731.)

AUGUST 11, 1939, LANGLEY FIELD, VA. Nine army fliers were killed when a twin-motored bombing plane crashed a few moments after taking off. When about 150 feet from the ground the plane dived suddenly and crashed. It burst into flames almost immediately, defeating efforts to rescue the men trapped within. (L-5732.)

AUGUST 20, 1939, OFF RYE BEACH, N. H. Charred wood washed ashore bore mute evidence of the fire which took the lives of five men and a woman whose bodies were also found on the beach. An investigation by the Coast Guard led to the theory that the victims had jumped from their 25-foot cabin cruiser after fire broke out on the boat. (L-5733.)

Foreign Fires.

Five fires, involving the loss of five or more lives each, have been reported during this quarter from outside the United States and Canada. These are not included in the tables, but summaries of these fires are given below.

JULY 3, 1939, CAGLIARI, ITALY. Five Italian navy men were burned to death when their hydroplane crashed while on a practice flight. (H-43226.)

JULY 10, 1939, MARSEILLES, FRANCE. Seven persons were burned to death in the fire that resulted when a package of photographic film became ignited in a bus nineteen miles from this city. Five others suffered burns. (H-43335.)

JULY 11, 1939, SEVILLE, SPAIN. Seven army officers and men were killed when their large plane fell in flames shortly after taking off. The plane fell on a fertilizer factory and set it on fire, but the blaze was quickly extinguished. (H-43332.)

JULY 16, 1939, AT SEA NEAR COLOMBO, CEYLON. Five members of the crew of the British passenger liner *Narkunda* were killed and 23 others injured by an explosion in one of the ship's holds. The cause of the explosion was not reported. (H-43333.)

Loss of Life Fires, July-September, 1939.*

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	No. Fires	Men	Women	Children	Total
Airplanes	3	13	0	0	13
Apartments, rooming houses, tenements, hotels	6	3	2	3	8
Automobiles, trucks	3	3	0	0	3
Tank truck fires	1	1	0	0	1
Churches and church property	1	0	1	0	1
Dwellings—rural	14	4	10	19	33
Dwellings—urban	38	19	19	15	53
Garages	4	9	0	0	9
Forest fires	6	10	0	0	10
Hospitals	1	0	1	0	1
Manufacturing occupancies—miscellaneous	3	3	0	0	3
Mercantile occupancies—miscellaneous	2	2	1	0	3
Lumber yards	1	1	0	0	1
Mining property	2	32	0	0	32
Out of doors	12	5	0	8	13
Prisons	2	2	0	0	2
Railroad cars	1	1	0	0	1
Restaurants	2	3	2	0	5
Yachts	3	6	1	1	8
Totals	105	117	37	46	200

*This table is made up from those reports received by the Department of Fire Record between June 24, 1939, and September 15, 1939. A few of the fires included herein occurred prior to June 24, but were not reported until subsequent to that date.

SEPTEMBER 11, 1939, LEMNOS, GREECE. A fire in a motion picture theatre brought death to forty persons, most of whom were children. Eighty others were injured. Further details are lacking. (H-43336.)

Causes of Loss of Life, July-September, 1939.

Class of Fire	Men	Women	Children	Total
Airplane fires	13	0	0	13
Automobile or truck collisions and fires	4	0	0	4
Children alone in house	0	0	4	4
Clothing ignited (other than following classification)	1	2	0	3
Bonfires, rubbish fires	1	0	1	2
Burning gasoline	1	0	1	2
Falling into fire	1	0	0	1
Matches	0	1	3	4
Smoking (see also smoking in bed)	0	1	0	1
Stove	0	3	2	5
Entering or re-entering a burning building	0	3	0	3
Escaping fires, jumped, fell or drowned	6	1	0	7
Explosions, miscellaneous	1	0	0	1
Butane	3	2	2	7
Chemicals	1	0	0	1
Fireworks	1	0	3	4
Illuminating gas	2	0	0	2
Fire fighting—firemen	8	0	0	8
Fire fighting—private individuals	5	0	0	5
Flammable liquid and vapor fires:				
Benzine used for cleaning purposes	5	0	0	5
Gasoline used for cleaning purposes	2	1	1	4
Gasoline used to start fire	1	0	1	2
Gasoline fires not otherwise classified	6	1	2	9
Kerosene used to start fire	0	2	6	8
Paint and varnish remover fires	1	0	2	3
Mine fires and explosions	32	0	0	32
Smoking in bed	3	4	0	7
Trapped in burning building	19	14	18	51
Indirect causes	0	2	0	2
Totals	117	37	46	200

Typical Loss of Life Fires.

Children Alone in House.

JUNE 3, 1939, ST. JOHN PLANTATION, MAINE. Four small children were burned to death when fire swept their home while their mother was visiting a neighbor. A defective stove is believed to have caused the fire. (L-5673.)

Children Playing with Matches.

JULY 4, 1939, WEST HAVERSTRAW, N. Y. A little girl was fatally burned when her clothes became ignited while she was playing with matches. (L-5715.)

JULY 18, 1939, CAPITOL HEIGHTS, MD. A five-year-old girl died of burns received when a box of matches became ignited in her hands as she played at her home. (L-5716.)

Clothing Ignited.

APRIL 7, 1939, EL DORADO, KAN. A woman was burned to death when her clothing became ignited by a kitchen stove. (L-5662.)

JUNE 21, 1939, CHICOUTIMI, P. Q. A small boy died from burns received when he picked up a piece of flaming paper. His clothing became ignited. (L-5601.)

JUNE 23, 1939, VAUDREUIL, P. Q. Blazing grease spilled over a kitchen stove caused the death of one nun and severely burned another. Both nuns ran from the kitchen with their habits on fire. Employees they met stifled the flames, but not until one of the victims was fatally burned. (L-5608.)

SEPTEMBER 8, 1939, WASHINGTON, D. C. An elderly woman died of burns received when her clothes became ignited as she attempted to light her way down the cellar stairs with a match. (L-5597.)

Escaping Fires.

JULY 26, 1939, LINDEN, TEXAS. Eight persons trapped on the third floor of a burning hotel were forced to jump for their lives, one of whom was killed in his plunge from a window. (L-5717.)

Fireworks.

JULY 4, 1939, ANNAPOLIS, MD. A man was killed by the explosion of a large firecracker which he had placed in a piece of iron pipe. He was apparently looking into the pipe when the explosion came, tearing off the top of his head. (L-5707.)

JULY 4, 1939, TURLOCK, CALIF. A boy died of burns received when a string of firecrackers exploded in his pocket. (L-5708.)

Flammable Liquids and Gases.

JUNE 2, 1939, PLYMOUTH, MASS. A five-year-old boy was fatally burned when he was struck by a can of burning gasoline that had been hurled by a truck driver after it had ignited accidentally. The driver was filling the tank of his truck from a can when the gasoline suddenly became ignited. Unaware that the boy was playing near by, he hurled the can away. It struck the child, spraying his body with the burning liquid. (L-5709.)

JUNE 13, 1939, LOVINGTON, N. M. Two small children were fatally burned and their grandfather seriously hurt by an explosion of butane gas at their home. The explosion occurred when the grandfather attempted to light the gas water heater in the basement of the house. Although the gas had been turned off for a day, apparently leaking gas had accumulated in the cellar and was ignited when an attempt was made to relight the burner. (L-5710.)

JUNE 27, 1939, ELIZABETH, N. J. The proprietor of a butcher shop was killed when fumes escaping from a refrigerator exploded. (L-5724.)

JULY 7, 1939, WOONSOCKET, R. I. A mother and daughter were fatally burned when a bed they were cleaning with a mixture of gasoline and kerosene became ignited and set fire to their clothing. (L-5711.)

JULY 16, 1939, TIMMINS, ONTARIO. A baby was burned to death when gasoline, being used by her father to start a stove fire, exploded and quickly destroyed their temporary frame home. Firemen were forced to lay 1500 feet of hose in order to reach the fire. (L-5723.)

AUGUST 3, 1939, CINCINNATI, OHIO. A man was burned to death when fumes of a benzine floor preparation exploded. At the time of the explosion the victim was treating the floors of a dwelling. He kept the windows closed to

prevent the filler from drying too quickly, but neglected to close the cold air return duct to a hot air furnace which was not in use at the time. The benzine vapor gravitated through this duct to the furnace casing, leaked through the casing and was ignited by a hot water heater 25 feet from the furnace. The flash traveled to the furnace, exploded the casing, and then passed up through the cold air duct, causing another explosion in the room where the victim was working. (L-5712.)

AUGUST 18, 1939, ST. NAZAIRE, P. Q. A woman and three children were fatally burned when fire destroyed their two-story frame home. The fire originated when the woman attempted to quicken a stove fire with kerosene, resulting in an explosion. (L-5713.)

AUGUST 26, 1939, BOSTON, MASS. Two boys were fatally burned when they ignited a pool of paint remover lying on the surface of a pond. The boys found a five-gallon can of paint remover in a dump, which they then carried to the edge of the pond and poured some of the fluid on to the surface of the water. One of the boys then threw a lighted match into the shallow water and the pool burst into flame. As the fire spread to the shore the boys attempted to stamp it out with the large can. The remaining paint remover splashed out of the can and saturated their clothing. There followed an explosion and the clothing of both became ignited. Instead of plunging into the pool the boys ran in the opposite direction. Their burns were so severe that they died at the hospital. (L-5734.)

SEPTEMBER 14, 1939, BOSTON, MASS. Sprayed with burning gasoline from head to waist when his automobile backfired as he was working on the carburetor, a man was so severely burned that he died a few hours later at a hospital. (L-5714.)

Re-entering Burning Buildings.

JULY 2, 1939, BLIND RIVER, ONTARIO. An elderly woman was burned to death in a futile effort to rescue a small child trapped in a burning dwelling. She had made one trip into the building to save the life of one of the children. She then returned to the blazing house in an effort to save the other child. Her body was found later a few feet from the door, the dead child clasped in her arms. (L-5721.)

JULY 26, 1939, JAY, MAINE. A woman was burned to death when she dashed back into her burning home in a vain attempt to rescue a state ward who lived with her. The dead pair were found near the door. (L-5722.)

Smoking in Bed.

JUNE 16, 1939, ALBANY, N. Y. A woman died of burns received when she fell asleep on a couch while smoking. (L-5718.)

JULY 25, 1939, CINCINNATI, OHIO. A man was burned to death when he fell asleep while smoking in bed. (L-5720.)

Trapped in Burning Buildings.

MAY 2, 1939, WOODLAND, CALIF. Two children were burned to death when trapped in a burning tourist cabin, where they were staying with their parents. The origin of the fire was not determined. Firemen prevented the spread of the flames to the ten other cabins in the auto camp. (L-5725.)